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ALOUETTE SPILLWAY AND LOW LEVEL OUTLET REHABILITATION

ENVIRONMENTAL MANAGEMENT PLAN

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TABLE OF CONTENTS

Section	Subject	Page
1.0	**INTRODUCTION**	1-1
1.1	Project Description	1-1
1.2	Fisheries Resource Description	1-4
1.3	Park Resource Description	1-6
2.0	**LONG TERM IMPACTS**	2-1
2.1	FISHERY IMPACTS	2-1
2.1.1	Description of Impacts	2-1
2.1.2	Mitigation - Fishery	2-2
2.2	RECREATION IMPACTS	2-2
2.2.1	Description of Impacts	2-2
	Access to East Side of Alouette Lake	2-2
	Visual	2-2
	Public safety	2-3
2.2.2	Mitigation - Recreation	2-3
	Access to East Side of Alouette Lake	2-3
	Visual	2-4
	Public Safety Measures	2-4
3.0	**CONSTRUCTION IMPACTS**	3-1
3.1	DESCRIPTION OF IMPACTS	3-1
3.1.1	Clearing and Excavation	3-1
3.1.2	Water Flow and Levels	3-1
3.1.3	Water Quality	3-3
3.1.4	Spoil Material	3-5
3.1.5	Access and Site Roads	3-6
3.1.6	Reduced Reservoir Operating Levels	3-8
3.1.7	Noise, Dust, Public Safety and Security	3-10
3.2	MITIGATION	3-10
3.2.1	Clearing and Excavation	3-10
3.2.2	Water Flow and Levels	3-12
3.2.3	Water Quality	3-13
3.2.4	Spoil Areas	3-18
3.2.5	Access and Site Roads	3-19
3.2.6	Reduced Reservoir Operating Levels	3-21
3.2.7	Noise, Dust, Public Safety and Security	3-22

Section	Subject	Page
4.0	ENVIRONMENTAL MONITORING AND INSPECTION PROGRAM	4-1
4.1	MONITORING	4-1
4.1.1	Construction Monitoring	4-1
4.1.2	Restoration Monitoring	4-2
4.1.3	Post Project Monitoring	4-2

LIST OF TABLES

Title	Page
Table 1 - Summary of Water Quality Observations December 1989 - January 1990	1-5
Table 2 - Gas Saturation in the Alouette River	3-4
Table 3 - Estimate of Construction Materials	3-7
Table 4 - Interim Maximum Normal Reservoir Levels	3-9
Table 5 - Construction Monitoring	4-1

LIST OF FIGURES

Title	Page
Figure 1 - Project Schedule	1-2
Figure 2 - General Arrangement Plan	1-3

REFERENCES R-1

APPENDIX:

1.	1989/90 Water Quality Observations	A1-1
2.	PreliminarySample Oil or Chemical Spill Contingency Plan	A2-1
3.	Dam Spill Contingency Plan	A3-1
4.	List of Contacts	A4-1
5.	Aquatic Habitat Restoration Plan	A5-1
6.	Runoff and Sediment Control Procedures	A6-1
7.	Spoil Area Rehabilitation Plan	A7-1
8.	Access Location Plan	A8-1
9.	Clearing and Excavation Rehabilitation Plan	A9-1
10.	Public Safety, Security and Parking Plans	A10-1

1.0 INTRODUCTION

Rehabilitation of the Alouette Dam spillway will affect the immediate area of the dam and spillway as well as the access routes to the dam. Prime concerns are the water quality and fish resources of the Alouette River as well as the highly used public recreation areas associated with the nearby Golden Ears Provincial Park. The nature of environmental impacts can be classified in two ways: those impacts attributed to the project itself, and those that would be the result of construction activities. The purpose of this Management Plan is to identify specific environmental impacts and to recommend detailed measures to mitigate them.

This plan is organized such that the resources in question are first described, then the potential impacts discussed, and finally an explanation of the the mitigative measures proposed. It is intended that this plan be updated as the project proceeds and more information is obtained.

1.1 Project Description

During 1991 to 1993 B.C. Hydro plans to rehabilitate the Alouette Dam spillway and to modify the existing spillway headworks. On completion of the spillway work Hydro will then also make improvements to the low level outlet gate and tower.

Specifically the rehabilitation work will entail:

1) widening of the spillway chute and replacement of the chute walls and invert, construction of a new stilling basin and rip-rap protection on the slopes of the stilling basin.

2) replacement of the existing three-gate headworks structure with an overflow weir section and one modified gate.

3) repair of the low level outlet tower and existing gate and the installation of an additional gate. (Details regarding the repair of the LLO tower and gate have not been finalized, thus environmental measures specific to this task have not been determined.)

Preparatory work on site roads, office pads, drill pads, the upstream coffer dam, construction of a power distribution line, and the initial phases of the environmental protection measures will begin in early spring 1991. Environmentally sensitive work in and around the Alouette River will be completed during the period 15 July - 15 September.

The project schedule is shown on Figure 1 and the General Arrangement Plan is Figure 2. Maintaining the schedule, particularly during 1992, will be critical. Once demolition of the spillway begins, early in 1992, the spillway will not be able to discharge water until repairs are completed. Since an

ACTIVITY	1990									1991													1992													1993											
	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
PRELIMINARY STUDIES																																													
PUBLIC CONSULTATION																																													
FINAL DESIGN FOR CONSTRUCTION																																													
PROJECT APPROVALS																																													
SITE PREPARATION																																													
TENDER MAIN CONTRACT																																													
SPILLWAY CONSTRUCTION																																													
COMPLETION WORK																																													
LOW LEVEL OUTLET REPAIRS																																													

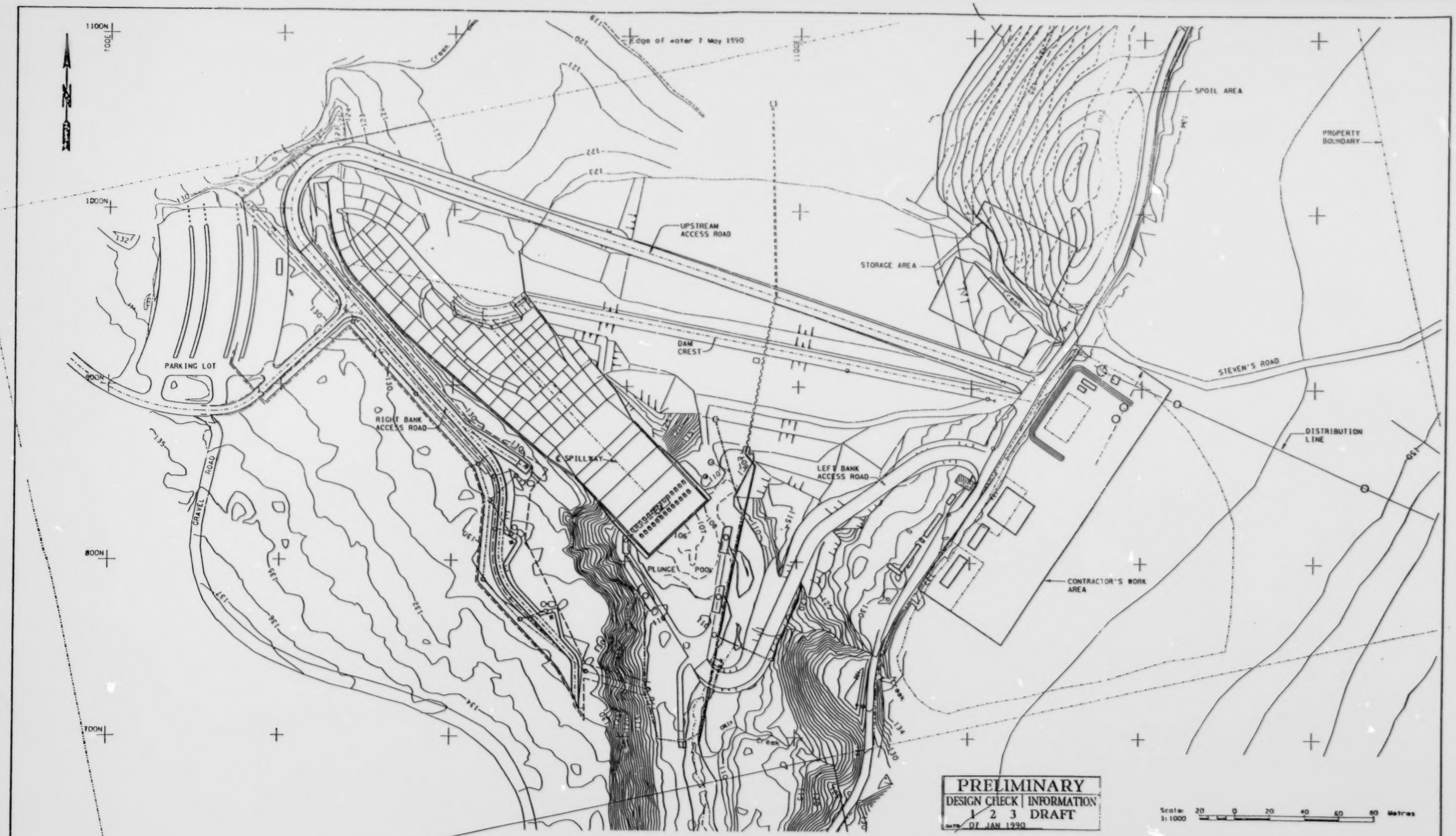
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

ALOUETTE DAM SAFETY PROJECT

SPILLWAY AND LOW LEVEL OUTLET REHABILITATION

DATE	FIG. 1
DEC 1990	
DWN	DRG No. 421-C14-C411
REPORT No.	

SEH AV/16oct1990


1100N
1000N
900N
800N
700N
Edge of water 7 May 1990
Creek
SPOIL AREA
PROPERTY BOUNDARY
UPSTREAM ACCESS ROAD
STORAGE AREA
DAM CREST
PARKING LOT
STEVEN'S ROAD
RIGHT BANK ACCESS ROAD
SPILLWAY
LEFT BANK ACCESS ROAD
DISTRIBUTION LINE
GRAVEL ROAD
PLUNGE POOL
CONTRACTOR'S WORK AREA
PRELIMINARY
DESIGN CHECK | INFORMATION
1 2 3 DRAFT
DATE 07 JAN 1990
Scale 1:1000
20 0 20 40 60 80 Metres
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
ALOUETTE DAM - SPILLWAY REHABILITATION
GENERAL ARRANGEMENT
AS SHOWN
FIG. 2

acceptable level of dam safety requires that the spillway be operational during the fall flood season, it is imperative that delays to the 1992 schedule be avoided.

1.2 Fisheries Resource Description

The Alouette system is an important contributor to the fisheries of the lower mainland area. Below the dam, the Alouette River supports four species of anadromous salmon plus steelhead and two species of resident trout. Above the dam, Alouette Lake supports lake char, rainbow trout, cutthroat trout, kokanee and Dolly Varden.

Spawning escapements of anadromous fish in the Alouette River are gradually increasing as a result of enhancement activities. Foremost among these is the fish hatchery and fish farm operated by the Ministry of Solicitor General at the Alouette River Correctional Centre (ARCC). Both of these facilities require water from the Alouette River at various phases of their operation and they are sensitive to variations in water levels and temperatures.

Salmon spawn in the Alouette River from late September through December (Hancock and Marshall 1985) and incubating eggs and alevins remain in the gravel until April. Chum and pink salmon typically use only the lower reaches of the river and migrate to sea soon after emerging from the gravel. Coho spawn throughout the river and their juveniles remain to rear in freshwater for a year prior to migrating to the ocean. As a result of their longer freshwater residence, coho are more sensitive to changes in freshwater habitat quality.

Trout spawning in the Alouette River occurs from late April through early June and extends upstream as far as the riffle below the dam (P. Caverhill, MOE pers. comm.). The resulting juveniles emerge from the gravel by early July. Juvenile steelhead remain in the stream for approximately two years prior to migrating to the ocean. Resident rainbow and cutthroat trout remain in the river throughout their lives.

One long term fisheries problem in the upper kilometre of the Alouette River is a shortage of spawning gravels. Construction of the dam in 1929 has cut off upstream sources of gravel while occasional spills have tended to displace existing gravel downstream.

Above the dam, Alouette Lake supports stocks of rainbow and cutthroat trout, Dolly Varden and lake char, plus kokanee. The trout and Dolly Varden spawn in the tributaries and rear for up to a year before moving down to the lake. Kokanee and lake char remain in the lake throughout their lives, spawning in late fall and early winter. The productivity of Alouette Lake is very low. However, its location adjacent to Golden Ears Provincial Park and to a major population centre means that the fishery provides well over 1,000 angler days of recreation per year (Knight 1987). In

recent years, the B.C. Ministry of Environment (MOE) and ARCC have cooperated on rearing cutthroat in pens located in the lake.

B.C. Hydro is required (Agreement with Dept. of Fisheries and Oceans, 1971) to release 0.06 m^3/sec.(2 cfs) from the Alouette dam low level outlet (LLO) and to maintain a minimum of 0.71 m^3/sec. (25 cfs) at the 232nd Street bridge. However, the LLO discharge has generally operated at approximately 0.6 m^3/sec.(20 cfs) with occasional increases during periods of warm summer weather.

The Alouette River differs from rivers below most hydro generating stations in that flows are generally very stable. Aside from spills, which occur infrequently, the base flow is relatively constant, varying only due to local inflow from creeks downstream of the dam. Over the years, facilities built downstream of the dam, such as the ARCC hatchery, have come to rely on this flow regime. Groundwater seepage under the dam is also thought to make an important contribution to both the quantity and the temperature regulation of the water in the lower river.

The waters of Alouette Lake and the upper Alouette River are usually very clear with low levels of turbidity, suspended sediments, conductivity and dissolved ions (Appendix 1). However, during heavy rainfall local inflows into the river below the dam often convey large sediment loads. Further, strong winds and flows into the reservoir can result in turbid water conditions around the reservoir shoreline. Water quality observations during the winter of 1989/90 are summarized in Table 1 following.

Table 1
Summary of water quality observations at the Discharge End of the Alouette Dam LLO - December 1989 - January 1990

Parameter	Minimum	Maximum
Suspended solids (mg/L)	<1	1
Turbidity (NTU)	0.5	1.4
pH	6.3	6.8
Conductivity (umhos/cm)	14	17
Hardness (Calculated, mg $CaCO_3$/L)	2	11

Suspended solids measurements were continued until April 20 1990, and were generally <1 mg/L although maximums of 12 and 40 mg/L were noted on February 19 and April 9, 1990 respectively.

1.3 Park Resource Description

Park and recreational use is quite extensive in the Alouette lake Area and along the Alouette River. With the day-use and camping facilities of Golden Ears Provincial Park located on the south west end of Alouette Lake there is a large and environmentally sensitive public population. Existing park facilities comprising a 343 unit campground, day use parking for 1,100 vehicles, a boat launch ramp

and extensive hiking and ecuestrian trail systems are centered on the west bank of the reservoir. Highly valued park land exists on the east bank adjacent to Hydro property; however development has not yet occurred due to the lack of vehicle access across the Alouette River.

Public use of the swimming beaches in Golden Ears Park is affected if summer time water levels fall below El. 123 m. If the elevation falls below 121.2 swimming is severely limited. For this reason the Ministry of Parks has requested that reservoir elevations be maintained above El.121.2 during the period from Victoria Day to Labour Day. B.C. Hydro's normal local operating order contains instructions for compliance with this request.

2.0 LONG TERM IMPACTS:

2.1 Fishery Impacts

2.1.1 Description of Impacts

Long term impacts associated with the spillway rehabilitation are likely to be limited to changes in the type of rearing habitat available to fish in the plunge pool area of the river. Changes in ogee shape and spill characteristics are likely to have a minor impact. The project is not anticipated to have any long term impacts on downstream habitats, river flow, or water quality.

Spillway rehabilitation will entail replacement of the existing concrete spillway with a wider structure and placement of rip-rap to protect the perimeter of the plunge pool and the edge of the apron. The new spillway will include a 51 m wide apron which will extend 22 m beyond the end of the existing spillway into the present plunge pool. The apron will cover an area of about 1,122 m^2 which is currently composed of boulder, rubble and fine sediments. Beyond the apron, an additional area of 550 m^2 will be surfaced with rip-rap similar to the existing rubble substrate. The apron will limit the maximum water depth to 5.2 m which is about the same as the existing pool at the deepest point. However, as the apron will be flat, the area over which the maximum depth extends will be larger, and the total volume of the pool will increase.

Apart from the spillway, the existing perimeter of the plunge pool is largely a shelving habitat with a boulder and fine substrate. Approximately 110 m of this shelving shoreline will be replaced by a more complex shape. The change in shape will result in an increase in shoreline length and will include 80 m of concrete and 90 m of rip-rap. The effect of this change will be to increase the physical capacity for rearing fish as the boulder interstices will provide excellent cover. Potential prey will be slightly reduced due to the absence of riparian vegetation with associated insect production and leaf drop.

Replacing the existing 3-bay headworks with a weir and single gate will mean that manual gate operations would not be essential to maintain the stability of the dam during passage of even the most extreme floods. Without gate operation the system will start to spill automatically when reservoir water levels exceed 125.51 m. However, as it is intended to maintain, whenever possible, the present use of gated discharge during flood passage there will be no change in the current practice of prespilling when the reservoir level exceeds El 124.5 m.

The spillway rehabilitation project will not have any long term effects on spawning habitats as the new concrete and

riprap will extend only part of the way across the plunge pool. The natural plunge pool outflow sill, which controls much of the stream character will be kept at an elevation of 109.5 m. As all of the spawning habitat is located downstream of this sill, it will be unaffected by the finished spillway. Similarly, the completed project should not affect either the long term LLO flows or groundwater seepage into the river.

2.1.2 Mitigation

The focus of long-term fisheries mitigation efforts will be to increase riparian productivity. Native species, such as salmon berry and alder will be encouraged around the unriprapped shorelines. The effect of this vegetation will be to replace the insect and leaf drop which will be impacted in the riprapped areas. Some effort will also be made to reduce the long term gravel supply problem by introducing additional river washed gravel in the area of the plunge pool sill during site rehabilitation. A fish habitat restoration plan is included in Appendix 5.

2.2 RECREATION IMPACTS

2.2.1 Description of Impacts

The rehabilitation of the Alouette spillway will result in minimal long term impacts on Golden Ears Provincial Park. The areas of concern include future vehicle access to the east shore of the reservoir, visual resources, public information opportunities and public safety.

Access to the East Side of Alouette Lake

During reconstruction of the Alouette Dam in 1983 the Ministry of Parks indicated that they had a future interest in gaining access to the highly valued park lands on the east shore of Alouette Lake. As a result of their interest the top of the dam was constructed to a width of 7 m to accommodate a future bridge across the spillway and access road across the dam. Alternate routes linking the east and west portions of the park have been identified, but any actions that preclude a crossing on the dam would eliminate the Ministry's preferred option for access to the east side of the reservoir.

Visual

As a result of the proximity of the Provincial Park to the Alouette dam the project will have an impact on the visual resources of the Park due to physical alteration of areas viewed from the park or encroachment onto park lands. Clearing and excavation on B.C. Hydro land to facilitate reconstruction of the spillway and spoiling of excavated material, both on Hydro and Park land on the east side of the reservoir will affect views from the park.

Construction activities will also result in temporary visual impacts. These will be addressed in part 3.

Public Safety

Public use levels exceed 470,000 persons annually (M.O.P. Park Data Handbook - 1988) at the day use area and campground on Alouette Lake. The proximity of several thousand people to the Alouette Dam and spillway project site accentuates the importance of a public safety program. Clearing and site road construction on the right bank of the spillway will make the area more accessible to the public. Also, rehabilitation of the spillway will require temporary removal or relocation of existing public safety devices such as fencing, signs and the debris boom which presently limits boater access to the spillway entrance. Failure to replace or reconstruct public safety facilities at the completion of construction would result in increased hazard to the public.

2.2.2 Mitigation

By implementing specific measures during the rehabilitation of the Alouette Dam spillway, impacts of the project on Golden Ears Provincial Park can be mitigated.

Access to the East Side of Alouette Lake

During the preliminary design of the spillway rehabilitation it was determined that the design of the new spillway will not preclude the future construction of a vehicle bridge. Therefore no mitigation measures with respect to future access to the east side of Alouette Lake are proposed in addition to the preliminary studies carried out to identify, for the Ministry of Parks, the crossing options available.

One option identified would require a 60 m single span bridge across the spillway plus a 15 m side span from the east wall of the spillway to the 7 m wide roadway along the crest of the Alouette dam. Another option would involve a bridge over the spillway and incorporated into the proposed new gate structure. A third option would involve a 110 m long multi-span bridge across the head pond immediately upstream of the spillway. In addition further options exist for crossing the Alouette River downstream of the dam and spillway. Other options may be available but were not identified in the preliminary studies undertaken.

Visual

The impacts of the project on the visual resources of Golden Ears Provincial Park will be mitigated by:

a) Careful planning to ensure that clearing and excavations are kept to the absolute minimum necessary. This

minimizes the area impacted and minimizes the need for restoration.

b) Careful monitoring of construction activities to ensure the buffer areas are not disturbed unnecessarily.

c) Planting vegetation in cleared areas. The use of native shrubs, trees, and ground covers to supplement proposed erosion control measures implemented during construction will allow disturbed areas to quickly blend in with established vegetation. Tall growing species will be strategically placed to screen affected areas from sensitive viewing areas. Landscape rehabilitation procedures are specified in Appendices 7, 8 and 9.

Public Safety

To ensure the continued safety of the boating public, the existing positive boater restraint system (combination debris boom) will be in place before reservoirs levels are returned to normal.

Safety fences will be replaced and permanent hazard warning signs will be installed.

3.0 CONSTRUCTION IMPACTS

Construction activities associated with rehabilitation of Alouette spillway will result in environmental impacts. The primary activities of clearing, excavating, road construction, disposal of spoil material, control of ground water, and placement of new concrete will all contribute to these impacts.

3.1 DESCRIPTION OF IMPACTS

3.1.1 Clearing and Excavation

Forest vegetation must be removed within B.C. Hydro property to construct site access roads and to prepare spoil disposal areas as well as work and staging areas. Clearing native vegetation will have an impact in three important areas. As mentioned in 2.2.2 there will be an immediate impact on the visual resources of Golden Ears Park. Secondly, the removal or disruption of the accumulated duff, litter, and humus on the forest floor will increase the potential for erosion. This is a concern in areas of steep and unstable materials. Thirdly, due to the removal of the riparian vegetation there could be an impact on water quality and fish resources. Removal of streamside vegetation can result in alterations in stream temperature, nutrients, insect drop and cover. The special effects of clearing on runoff and sedimentation and with regard to road construction are noted in following sections.

Excavations are required for widening and replacement of the spillway chute and chute walls as well as for construction of the new stilling basin. These have the potential to create serious siltation problems in the Alouette River. The specific adverse impacts of siltation in river systems are discussed in section 3.1.3.

3.1.2 Water Flow and Levels

Dewatering

Surface water patterns both above and below the dam must be altered to facilitate the spillway rehabilitation. Stream diversion and its accompanying fish habitat alienation will be necessary below the dam as water must be removed from the plunge pool and adjoining areas. This is required to provide access to the lower portion of the dam, to facilitate excavation for the spillway and its apron, and to permit concrete placement. In order to dewater the site, a temporary extension pipeline has been installed and will be connected to the LLO. Groundwater seepage immediately downstream of the dam will be reduced by well pumping. Other short term changes in streamflow may occur during connection of the LLO extension and when factors such as water quality maintenance require increased discharges. Above the dam, water levels in the reservoir will be lowered to reduce the possibility of a spill.

The existing diversion consisting of welded steel pipe, 61 cm in diameter with an energy dissipating baffle at its discharge end extends to a location downstream of the proposed work areas approximately 150 m from the dam. (The extension pipeline was initially installed in January 1990 to facilitate the drilling of test wells and performing pump tests. It was disconnected following completion of the pump test in April 1990.) The pipeline will be reconnected to the LLO prior to the commencement of work in the Alouette River channel. The immediate impact of this diversion will be to alienate 150 linear metres of fish habitat. The lost habitat covers an area of 5,814 m^2 and consists of 3,380 m^2 deep pool, 910 m^2 shallow (1 m) pool, 944 m^2 glide, 330 m^2 riffle, plus a 250 m^2 seepage channel which parallels the west bank of the river (See Appendix 5). The entire area is important to the production of fish and is used by rearing coho. Areas of particular interest include a 118 m^2 riffle used by spawning coho, and a 106 m^2 riffle occupied by rearing steelhead. Resident trout utilize all of the deep pool habitat.

Groundwater will be pumped from nine dewatering wells with flows from five of the wells (0.14 - 0.17 m^3/sec.) discharged into the Alouette River together with the flows in the LLO extension pipeline. This will ensure that the quantity and temperature and regulating effects of groundwater seepage in the river are not altered.

Some variation in the overall water releases from the site may occur during the work. For example, during connection and disconnection of the diversion pipeline, it may be necessary to pump the required water flow over the dam. Some overlap between the pipeline and the pumps is inevitable and a short term increase in discharge may result. Of itself, the increase is unlikely to result in adverse impacts. However, if discharge is returned to previous levels too rapidly, fish may be stranded or become susceptible to increased predation. Conversely, if temporary water supplies are not provided during pipeline changeovers, possible impacts can include: stranding of juvenile fish, desiccation of eggs and alevins incubating in the gravel, and the inhibition or disruption of spawning activity.

In past years summer water temperatures in the Alouette River have exceeded 19°C and approached lethal levels for salmon and trout. It was found that spills of surface water from the lake were too warm and made the problem worse. The most effective solution has been to release additional amounts of water from the LLO. Low water levels in the reservoir and the present condition of the LLO intake may limit the ability to discharge enough water to regulate water temperatures.

Creek "A"

During a hydraulic review of Creek "A", which enters the reservoir immediately upstream of the dam on the right bank, it

has been determined that it has the potential (during PMF conditions) to overflow its banks and undermine the spillway. In order to prevent this it will be necessary to reinforce the creek channel. The specific requirements have not been determined but could include the construction of a berm and enlargement of culverts under the overflow parking lot road and the abandoned road further to the east. Since Creek "A" originates within the provincial park these modifications will affect park lands.

3.1.3 Water Quality

General

Construction activities at the Alouette dam site have the potential to seriously impact water quality in the Alouette River. Possible problems include silt introduction, changes in temperature, reduced oxygen levels, oil or chemical spills, and pH effects.

Sedimentation

Silts and fine materials introduced to river systems can have a number of adverse impacts. Most serious is the smothering of incubating eggs and alevins by fine particles. Slightly larger particles can result in gill irritation and lowered survivals in juvenile fishes. Third, the increased turbidity associated with silt limits light penetration which in turn may reduce photosynthesis and system productivity. Controlling siltation during spillway rehabilitation will be a major concern as the area surrounding the dam is largely composed of sand and fine silts which could enter the river system during a number of activities such as: road construction, clearing, excavation, and demolition.

Timing will have a significant impact on the magnitude of erosion and silt problems. Rainfall can quickly erode exposed surfaces and carry the fine materials to the river. The problem could be further exacerbated by rain on snow events which are common at this site during the winter.

Ground Water

During March 1990 tests it was found that the groundwater from dewatering wells on the site contained only 0.1 - 0.2 mg/L dissolved oxygen but had supersaturated (122 %) amounts of nitrogen (Table 2). Both are well beyond lethal limits for fish. It will, therefore, be necessary to take care that this water is either diluted with large amounts of oxygen saturated water, or aerated prior to release. Under normal conditions this groundwater seeps into the river over a broad area and mixes with the ambient water with no deleterious effect. The well discharge would represent a high volume point source which would result in a large downstream plume of this low oxygen/high nitrogen water.

Table 2
Gas Saturation in the Alouette River

Source	Temp. (°C)	Total Gas (% Sat)	O_2 (% Sat)	N_2 (% Sat)
Observed				
Well (March 20,1990)	8.5	97.0	1.3	122.5
LLO (May 1, 1990)	7.8	100.0	97.4	100.7
LLO (August 23, 1990)	20.0	99.2	96.2	100.3
Calculated				
May Mix(4:1*)	7.9	99.5	78.5	105.1
August Mix (4:1*)	17.7	99.5	73.0	106.6

* LLO discharge nominally 0.57 m^3/sec. (20 cfs), dewatering wells discharged to river estimated to be 0.14 - 0.17 m^3/sec (5 cfs).

Oil and Fuel

Construction activities and the operation and maintenance of machinery will require the use of fuels, lubricating oils, and hydraulic fluids. Adverse impacts may result either from spills during construction which enter the river, or from spills which saturate the substrate and seep out again when the area is flooded after construction.

Concrete and Shotcrete

The Alouette River, is slightly acidic with a pH of 6.3 - 6.8, (Table 1) but being extremely soft water, it is quite susceptible to pH change. Rehabilitation of the Alouette spillway will entail the placing and curing of a large amount of concrete. In addition a relatively small amount of shotcrete will be used.

Unless carefully controlled, curing solutions, and run-off from the fresh concrete or shotcrete can adversely impact water quality (concrete will not be batched on site but shotcrete will be dry mixed on site). Where pH in the river exceeds 8.5, fish are likely to have reduced survivals (CCROM 1987).

Reservoir Spill

Lower water levels in the lake will reduce the likelihood of having to release water through the spillway as the lake will have increased capacity to contain storm runoff. None the less, the remote possibility remains. The impact of a spill would vary somewhat with the excavation and construction stages but could include increased siltation, plus oil and fuel contamination from flooded tanks or machinery and could be a hazard to public safety.

If a spill is required in the fall or winter of 1991, then the dewatering facilities, work areas, and site roads in the plunge pool area constructed in preparation for the main work in 1992 could be damaged, resulting in delays to the start of work in 1992. Delays to the 1992 construction activity, either at the start or due to circumstances arising during the performance of the work that could prevent completion of the spillway prior to the fall flood season would expose the construction site, the Alouette River, and residents along the river to the risk of catastrophic damage since spilling water through the uncompleted spillway could result in its failure and release of the reservoir.

The first spill following completion of the spillway rehabilitation and the removal of the work areas and access roads will mobilize any residual silts and/or contaminants.

3.1.4 Spoil Material

Rehabilitation of the Alouette spillway will result in the removal of 60,000 to 70,000 m^3 of silt, sand, and broken concrete. Disposal of this material will require specific measures depending on the placement method and site chosen. Sites under consideration include disposal upstream of the dam on Provincial Park lands, and other adjacent B.C. Hydro owned land.

Disposal upstream of the dam and below full pool level, if improperly planned and controlled, could result in a sedimentation and water quality problems in the reservoir and eventually downstream as well. During the summer months increased turbidity in the reservoir could adversely affect recreational use of the reservoir.

During the rehabilitation of the dam in 1983 the area upstream of the dam was investigated by B. Apland, Director of the Archaeological and Outdoor Recreation Branch of the Ministry of Municipal Affairs, Recreation and Culture and C.W. Gurnsey, Manager, Land and Social Resources, B.C. Hydro Environmental Resources. At that time it was determined that an area upstream and to the south of the intake tower is an archaeological site. Recommendations were made to the then project manager that the area not be impacted by heavy equipment or by the placement of spoil material.

In addition, a portion of the site being considered on the east bank of the reservoir is Park land with high development potential as a picnic site and beach.

The use of other potential disposal sites will also require careful selection and rehabilitative measures to avoid sedimentation problems or permanent visual impacts on adjacent Park lands.

3.1.5 Access Roads and Site Roads

The development of roads in forest areas can have a number of effects on aquatic systems as well as visual impacts.

The predominant impacts of road construction on aquatic systems are:

a). Vegetation disturbance and destruction: resulting in visual scarring, and increased erosion. The impact is particularly significant when road construction occurs adjacent to stream banks and results in the destruction of riparian vegetation.

b). Accelerated erosion: occurs as a result of the removal of forest cover, the breakdown of soil structure, increased gradients of cut slopes, compaction and reduced infiltration, and concentration of water on or by the road. The dominant impact of accelerated erosion is increased siltation.

c) Flooding: resulting from destruction of drainage channels, clearing and removal or disturbance of ground cover.

d). Crossings: construction related flow diversions and increased sedimentation are impacts that affect fish and water quality. Inadequate crossing structures such as improperly designed culverts, could reduce flow or prevent fish passage.

Construction Access

There are three possible routes that can serve as the main construction access to the Alouette dam. The selected route or routes will be subject to heavy construction traffic at times as shown in the following table.

Table 3

Estimate of Construction Materials

Type of Material	Truckloads	Comments
Concrete	1,200	Concrete is assumed to be delivered in transit mixers from commercial batch plants in Maple Ridge, Mission and nearby areas. Required April to November 1992.
Rip Rap (Rock)	2,500	Required July 1991 and July 1992 - January 1992.
Misc. Fill	3,500	Sand and Gravel from local pits either near site or from Maple Ridge
Misc. Materials	5/day	Reinforcing steel, lumber, tools and light equipment. May 1991-December 1992.
Heavy Equipment	50	Required June 1991 - early 1993.

Each route will involve specific environmental and social impacts. All routes go through rural residential areas, pass schools and community parks. Social concerns will be dealt with separately and have involved a public consultation program. The possible access routes are:

a). 256th Street and Stevens Road. This route has been identified by the Municipality of Maple Ridge as an industrial road and could be used with some upgrading of Stevens Road. Upgrading of the last 8 km section involving resurfacing and improvement of sight line distances and some culvert repair will be required.

Local residents are concerned about potential increases in heavy traffic on 256th Street resulting from development in the Stevens Road area.

This road crosses both privately owned and crown land. Permission to use this road is being sought from both the private owners and the crown.

b). 248th Street and the B.C. Hydro road along the Alouette River. The B.C. Hydro road is in poor condition and would require upgrading in the form of resurfacing and improvement of site distances and repair to some culverts.

Local residents are concerned about potential increases in traffic on 248th street.

c). 232nd Street, Fern Crescent, Golden Ears Park Road. Traffic along this route is already heavy due to the large numbers of people that visit Golden Ears Park during the summer peak use period. The Ministry of Parks will not approve the use of the park road for construction vehicles during the period March 1 to November 12.

Recreational Use of Access Roads

Portions of the Stevens Road and the Hydro roads are used for recreation. Most notable is the use of these roads as bridle paths which comprise a portion of an extensive equestrian trail system originating at Allco Park. The system also includes trails in Golden Ears Provincial Park and other riding trails east of the Alouette River.

The Fraser Valley Endurance Riders host an annual two day horse and rider endurance race during May each year. This race utilizes portions of the Hydro and Stevens roads, with permission granted by B.C. Hydro on an annual basis.

In addition other informal recreational use including hiking and cycling occurs on these roads.

Increased use of these roads by B.C. Hydro and contractors during the rehabilitation of the Alouette dam spillway could be hazardous to these recreational users.

Construction Parking

B.C. Hydro plans to utilize the parking areas located on Hydro property near the west edge of the spillway. These lots were constructed for use by the Ministry of Parks as overflow parking in conjunction with the Alouette day-use beach and picnic area and are generally used on Sundays and statutory holidays between the middle of June and the middle of September.

Utilization of day-use parking areas for on-site parking by the construction labour force would usurp public parking spaces during peak recreational use periods (summer weekends and holidays).

3.1.6 Reduced Reservoir Operating Levels

During 1990 to 1993, B.C. Hydro will endeavor to maintain lower than usual Alouette Lake levels, when weather conditions permit, to minimize the risk of having to use the spillway until after the spillway has been rehabilitated as shown in Table 4.

Table 4
Interim Maximum Normal Reservoir Levels (Metres)

Summer 1991	Winter 1991	Summer 1992	Winter 1992
El. 122.5	El. 117.0	El. 121.5	El. 117.0

Note:
Summer Interim Maximum Reservoir Levels (IMNRL) apply between Victoria Day and Labour Day. Winter levels apply for the period 1 October to 1 April.

The INMRL is the starting level required to safely pass the 1000 year return period flood.

Winter IMNRL levels are tentative and are subject to further refinement.

Lowered reservoir levels could affect fish resources and the use of swimming beaches in Golden Ears Provincial Park.

The potential impact on fish is threefold. First, the reduced head at the LLO may result in reduced discharge capability. Secondly, during summer, water withdrawal at the intake could be close to the surface and be warmer than normal. Third, if extreme drawdowns follow fall kokanee spawning, then losses of incubating eggs and alevins due to desiccation may occur.

In Golden Ears Provincial Park this requirement may result in reduced utility of the swimming beaches at the day-use area and the campground.

The day-use beach at the provincial park picnic area is approximately 300 metres long and is situated just upstream of the Alouette dam on the west shore of Alouette Lake. The beach was artificially constructed in 1964. Major repairs were made to the beach in 1973 and minor repairs were last made in 1987. Prior to the Spillway Rehabilitation Project sand extended from slightly above normal high water down to approximately El. 123 m. The quality of the beach had deteriorated progressively at lower elevations. Below elevation 122.5 m the beach was extremely rocky, with the worst areas being at the west end of the beach. During normal years the summer water levels generally fall between 123 m and 124 m. The maximum wetted beach available during this time extended only to a depth of approximately 1 m. A good swimming beach should have sand extending to a water depth of 1.5 m (approximately El. 121.5 m at normal operating levels).

During April 1990 B.C. Hydro funded improvements to the beaches to mitigate the impact of lowered reservoir operation (to El. 122.5 m) on beach use during the summer months. Approximately 2,400 m^3 of sand was added to the beach extending the sanded area to El. 121 m.

Further lowering of the reservoir operating level to El. 121.5 m during the summer of the construction year will have an impact on the use of the beach by the public. Water levels below 116 m seriously impact the utility of the public boat launch ramp.

The Campers' beach is located approximately 4 km up the reservoir on the west shore adjacent to the Gold Creek Campground. The beach is naturally formed of gravel/coarse sand and is substantially smaller than the day-use beach. This beach was upgraded during 1990 as well. The impact of reduced reservoir operating levels on the public use of the Campers' beach would be similar to the day-use beach.

3.1.7 Noise, Dust, Public Safety and Security

The project will require a large amount of heavy equipment, including excavators, trucks, pumps, cranes etc. This will create significant amounts of noise in a semi wilderness recreation area. Any noise created at night will be of particular concern due to the proximity of the large campground in Golden Ears park.

The movement of heavy trucks within, to, and from the work site may create quantities of dust particularly during extended dry periods. These periods generally coincide with high recreational use periods.

With large concentrations of the public in close proximity during construction, public safety and general security of the work site is critical. From an environmental perspective, acts of vandalism resulting in damage to environmental protection measures or to fuel or lubricant storage facilities could have serious consequences.

3.2 MITIGATION

3.2.1 Clearing and Excavation

The impact of clearing for project activities will be mitigated by implementation of the following measures:

a). Areas to be cleared will be minimized by careful planning and layout of work areas, excavations, and roads. Any areas not required for these purposes will be protected and remain undisturbed throughout the term of the project. The ultimate success of restoration programs are enhanced by retaining as much undisturbed natural

vegetation as possible. For this reason areas where vegetation is to be retained will not be used for any other purpose such as storage of materials, parking of equipment, piling of slash or debris etc. All clearing boundaries will be flagged in the field prior to commencement of clearing.

b). Drainage and sediment control devices sufficient to protect exposed areas will be installed as early as practical and will generally be in place prior to undertaking clearing in areas which are steep and/or unstable and/or immediately adjacent to the Alouette River or its tributaries.(see section 3.2.2 Water Quality and Appendix 6).

c). All timber will be hand felled and care will be taken to avoid falling timber into the Alouette River, tributaries, or outside the clearing boundaries. Slash and debris will not be deposited in the Alouette River channel, tributaries or outside the clearing boundaries (other than designated disposal areas).

d). Care will be taken when yarding timber to avoid crossing the Alouette River or tributaries. Timber will not be skidded or yarded through uncleared areas or in such a way as to damage drainage or sediment control measures.

e). Timber will be decked within designated work areas. Upon the removal of felled timber all slash and other materials that might impede the flow of water will be disposed of by burning or removal to a designated disposal area.

* f). Merchantable timber will be salvaged and removed from the site. Non-merchantable timber will be disposed of.

g). The mitigation of impacts resulting from the clearing of project areas requires the replacement with native vegetation species throughout. Details and specifications for achieving this are contained in the attached Clearing and Excavation Rehabilitation Plan (see Appendix 9, Fig. 9-1).

The excavation necessary to widen the spillway chute to extend the chute walls, and to construct the new stilling basin will be completed as shown on the project drawings. Measures for control of sedimentation associated with material excavation are described generally in section 3.2.3 and more specifically in Appendix 6 - Runoff and Sediment Control Procedures. Long term restoration requirements are included in Appendix 9, Fig. 9-1.

3.2.2 Water Flow and Levels

The impacts of water flow variations resulting from construction activities will be minimized where possible and, where impacts are unavoidable, steps will be taken following construction to improve the fish habitat and ensure the long term productivity of the resource.

De-watering

One impact of the construction which is unavoidable is the alienation of 150 m of fish habitat below the dam by diversion and dewatering. There is no way to reduce this loss as the spillway extends out into the river, and some additional area will be required for access and staging. Mitigation efforts will therefore focus on fish exclusion and salvage before construction, on providing new spawning substrates below the site, and on improving the value of the habitat after construction. Habitat improvement after the project will primarily entail placements of 25 mm - 75 mm river gravels in the 80 m of stream below the lip of the plunge pool. The objective will be to improve the quality of the spawning habitat in this section of the river. Details of the Fish Habitat restoration plans are found in Appendix 5.

Approximately 0.14 - 0.17 m^3/sec. of the groundwater from the dewatering wells will be discharged into the lower river to ensure that its volume and temperature moderating effects are not lost to the system. Groundwater from wells distant from the river will be discharged into Alouette Lake. Groundwater treatment is reviewed in Section 3.2.3 following.

Changes in discharge arrangements, such as changes from LLO to the diversion pipeline will be carefully managed to ensure minimal disruption of spawning and rearing fish in the lower river. Refitting the extension to the LLO will not require disruption of flows. However, should problems arise, the flow in the Alouette River will be maintained by pumps. In that case, the supplementary pumps will be brought on stream one at a time, as the LLO valve is closed, so that total discharge remains approximately constant. In this manner, the risk of stranding fish in the lower river will be minimized. A specific Activity Sequence will be prepared prior to each change in discharge arrangement.

Rewatering

At the conclusion of construction, flows will be reintroduced to the watercourse carefully in order to minimize the possibility of siltation. Clean river gravel will be used throughout the habitat restoration (Appendix 5). However, given the nature of the project and the size of the excavation it is inevitable that some silts and fines will remain in the water course. To

minimize the contamination of downstream areas, the following sequence will be followed:

a). Fish habitat restoration will be completed.

b). De-watering pumps will be turned off.

c). The plunge pool and watercourse will be allowed to recharge naturally. This slow filling will permit sediments to settle well into substrate interstices. If the natural recharge rate is too slow (taking more than a few days) it will be augmented with water from the valves in the LLO extension pipeline near the base of the dam. Downstream oil booms will remain in place during this step to collect any pollutants which may float up as the pool fills.

d). Once the plunge pool is full, water has started over the natural sill that defines the downstream edge of the pool, and any turbidity in the pool has cleared, the LLO extension pipeline will be removed.

Creek "A"

Since proposals to ensure that flows from Creek "A" (under PMF conditions) cannot undermine the spillway have yet to be developed no mitigative measures have been specified. Mitigation designed to minimize adverse environmental impact associated with containing PMF flows in Creek "A" will be determined through discussion with the Ministry of Parks and the Ministry of Environment.

3.2.3 Water Quality

General

During the construction phase, water quality in the Alouette River will be maintained through runoff control, groundwater treatment, and management of machinery, fuels and lubricants. Where practical, water quality protection measures will be initiated at the start of each phase of the construction program to protect against the impacts which could occur during that phase.

Sedimentation

The Department of Fisheries and Oceans have advised that suspended solids should not exceed 5 mg/L above background levels "immediately downstream from the site" (O.E. Langer, DFO 4 December 1990) although some increase may be possible during the period from late July through early September (L. Dutta, DFO pers. comm.). During the project B.C. Hydro will endeavor to meet this criteria by employing a variety of measures including:

- Construction timing.
- Diversion of runoff from catchment areas above the construction site.
- Slope protection.
- Containment and disposal of silt laden water in the construction site.
- Isolating cells within the work areas such that clean runoff does not become contaminated by silt laden water from disturbed areas.
- Allowing restored areas of the water course to settle prior to reintroducing flows.

Timing is a key element of erosion and siltation control. Initial access road and drainage system construction close to the river will be completed during late July through September, 1991 when relatively dry conditions can be expected. Every effort will be made during the main contract period in 1992 to avoid delays in the construction schedule that could result in increased exposure to the high risk of erosion and water quality problems which accompany winter conditions of regular rain, snowfall and potential flood conditions. An environmental monitoring program will be implemented (4.1.1 Construction Monitoring) that will endeavor to identify potential water quality problems at the earliest possible time. Environmental agency staff will be fully informed of potential problems to ensure that quick and effective solutions are implemented and delays are avoided.

The total amount of water crossing the site, and thus the potential for erosion, will be decreased by diverting water from upland areas away from the site. Erosion resistant ditches and/or half culverts will be used along the slope on the west side of the project. On the eastern side, the new access roads will be ditched and flow from this area, together with that from two creeks which enter the site, will be diverted away from the work areas.

Slope protection will be an integral part of the access road construction and excavation phases (see 3.2.1 and 3.2.5) and will focus on minimizing exposed areas and reducing water velocities through the use of terraces, wattle fences, water bars, seeding, and geotextiles. All slopes not hydroseeded by October 1 of any year will be protected with erosion control mats or similar means.

During the construction phase, a drainage system within the site will be constructed to direct runoff from disturbed areas to sumps and from there pumped to a deep disposal area in the reservoir. The facilities will be of sufficient capacity to handle expected runoff in the work site for conditions up to the 10 year storm (24 hour duration). The 10 year storm has been calculated as constituting 157 mm of precipitation over a 24 hour period. It has been estimated under these conditions that surface runoff for the total work site would reach 4500 l/min.

The effectiveness of the system will be increased by dividing the work areas into a number of isolated cells such that clean water from undisturbed areas would not become contaminated by silty water from disturbed areas. As a result, the total amount of silty water to be discharged will be reduced by approximately 50%.

The disposal of up to 2250 l/min. of silt laden surface runoff from the work area will be accomplished by pumping to a location in the Alouette Reservoir approximately 1100 m upstream of the dam. Surface runoff will be dispersed into the reservoir at an average depth of approximately 30 m.

Further details regarding drainage control measures, slope protection, and the collection and removal of silt laden water are specified in Appendix 6.

Ground Water and Gas Saturation

Groundwater discharged from dewatering pumps will be handled in a manner which ensures that there are no harmful effects on organisms in the receiving waters. As the untreated groundwater has oxygen and nitrogen levels well beyond lethal levels for fish, three methods will be used to ensure that discharges remain within safe levels (O_2 > 80% saturation; N_2 < 102% saturation; Davis 1975, Sigma 1983). The discharge from wells on the south side of the excavation will be aerated and released to the river (about 0.14 - 0.17 m^3/sec.). Water from wells on the west side of the excavation (approximately 0.12 m^3/sec.) will be collected in a ditch and allowed to aerate as it flows to the reservoir.
* The well on the north side of the excavation (about 0.05 m^3/sec.)
* will be aerated and piped over the dam to the reservoir.

Water discharged from the site will be monitored closely. If unacceptable oxygen or silt levels are observed, the source will be identified and changes will be made immediately. Basic gas saturation problems will be remedied by aeration. An additional
* remedy could include increasing the supply from the lake.

River Crossing

One of the first tasks in the stream channel will be to place a culvert and construct a road across the stream approximately 130 m downstream of the dam. This is likely to result in the introduction of some silt into the river. However, problems associated with these measures will be reduced by the following steps:

a). Construction will take place between late July and mid September 1991 when there are no incubating eggs or alevins in the gravel.

b). Work will not begin until the diversion pipeline and fish

exclusion fences are operating so that water flow through the crossing site is minimal. If necessary, sump pumps will be used to further reduce flow through the access road area.

c). The first loads of material which are placed in the watercourse to stop the flow will be clean rock fill to minimize the introduction of silt into the river.

Oil and Fuel

Machinery working on the site will require a variety of fuels and lubricants. To reduce the risk of these fluids reaching the Alouette River, an oil spill contingency plan similar to the preliminary plan shown in Appendix 2 will be designed and implemented. The principal components will include:

a). Fuel storage to be located at least 50 m from the river. Large tanks to have impervious containment facilities or dykes capable of holding the entire contents of the tank. Facilities to be inspected daily and rainwater will be removed.

b). Machinery working within the diversion area, where possible, to be removed for servicing. Where machinery is not mobile, the equipment is to be equipped with drip trays or impervious containment dykes. Drip containment facilities to be inspected and cleaned regularly and sorbent pads to be replaced as necessary.

c). Clean up materials and equipment, such as sorbent pads, 45 gal drums with lids, and an oil skimmer to be available on site.

d). Pump sumps to be equipped with oil spill booms so that spills can be collected before they leave the site. Oil booms to be inspected regularly and any oil collected to be removed immediately.

e). Contaminated substrates to be removed from diversion and riparian areas. This will ensure first, that additional areas are not contaminated and second, that the spilt materials do not seep back out after the watercourse is restored.

f). Personnel responsible for oil spill response to review the plan regularly to ensure that it is up to date and that all of the required materials are on site.

g). An oil boom to be installed across the river immediately downstream of the work site. This will ensure that any spills are contained within the work area.

Concrete

The spillway rehabilitation entails placing 13,000 m^3 of concrete. While the concrete is curing, runoff from this area could have a high pH. Containment facilities will be built in conjunction with the surface water handling system to capture any deleterious materials which could be harmful to fish. Runoff will be diluted to ensure that discharge pH does not exceed 8.

Reservoir Spill During Construction

The interim operating orders for the Alouette Reservoir during the construction period are designed to limit the annual probability of a reservoir spill to 1 in 1,000. None the less, a contingency plan will be developed to minimize the impacts in the event a reservoir spill cannot be avoided. Principle components of the Reservoir Spill Contingency plan are:

a). Procedures for activating the Alouette Dam Emergency Preparedness Plan

b). A communication system established to ensure immediate communication between B.C. Hydro Production Department, Lower Mainland Control Centre and the work site and appropriate agencies.

c). A detailed plan for removal of equipment and materials from the river area.

Other measures that will be taken include:

a). The preparatory site facilities to be constructed in 1991 will be designed taking into account that a reservoir spill may be necessary in the fall/winter of 1991.

b). The progress of the work will be closely monitored to ensure essential completion of the spillway prior to the 1992 flood season. Contingency plans will be prepared in advance and implemented if the potential for delays develops.

Reservoir Spill After Completion of Work

After completion of the spillway rehabilitation and removal of work areas and access roads the first reservoir spill will mobilize residual silts and pollutants and carry them into the Alouette River. The impact of this will be minimized by the following:

a). Prior to operation of the spillway and removal of the low level outlet extension water levels in the stilling basin will be returned to normal through decommissioning of the dewatering wells and the surface water disposal system. During this period sediments will be allowed to settle

and any pollutants will be collected in oil booms. (See 3.2.2 Re-watering).

b). The first reservoir spill will if possible, be arranged such to ensure that its size and duration is sufficient to transport any sediment downstream beyond fish spawning and rearing areas. The scheduling of the first spill to coincide with periods of high natural inflows into the river will further mitigate this impact.

3.2.4 Spoil Areas

The design of spoil areas is critical to ensure that the potential for environmental damage is minimized. In general terms the following measures will be taken to ensure the long term integrity of spoil areas.

a). Broken concrete will be buried to a minimum depth of 1.0 m. Rebar will be cut off and laid flat.

b). The toe of the spoil material will be contained with a rock or granular fill dyke.

c). The material will be placed at a maximum grade of 15% and the surface will be graded such that there are no depressions that will collect runoff.

d). Existing drainage courses within or adjacent to the proposed spoil area(s) will be armored with erosion resistant material and/or diverted.

e). Immediately following completion of spoiling activities the area will be seeded to grass.

Where material is to be spoiled on Provincial Park lands, special provisions will be necessary to ensure that park values are maintained. The area under consideration in Golden Ears Park comprises a potential day-use area fronting on the east shore of Alouette Lake. The following measures will be required:

a). The material will be evenly graded to avoid creating steep dropoffs. The maximum grade for potential picnic areas fronting on beach areas will be 10%.

b). If material is placed below the maximum reservoir level then the maximum gradient allowable will be 8%. Steep dropoffs will be avoided above El 120 m.

c). Material placed below the full reservoir level will be capped with sand or fine gravel. A protective dyke (below El. 120 m) will be placed to minimize wave induced erosion.

d). Material placed in potential picnic areas will be capped with soil capable of supporting vegetation and will be seeded to grass.

If placement of spoil on the unrecorded Archaeological site inspected in 1983 by Apland and Gurnsey is unavoidable, an archaeological assessment will be undertaken to determine the extent of mitigation necessary.

3.2.5 Access Roads and Site Roads

Environmental protection associated with road construction will be achieved by careful planning, enforcement of specific standards, and implementation of on site controls.

All roads will be constructed in accordance with B.C. Hydro drawings and specifications and with the plan shown in Appendix 8. The documents will specify how access will be developed. In addition, the plan will include specifications for road construction and provisions for protection of the water quality of the Alouette River and its tributaries as well as provisions for rehabilitation and maintenance following construction.

General provisions designed to provide environmental protection include:

a). Site road construction, in areas close to the river, will be scheduled to occur during the period mid July to mid September 1991.

b). Roadway clearing widths and grades will be minimized.

c). New road construction will be minimized by using existing roads.

d). At the same time as new site roads are built measures designed to intercept and divert surface runoff away from the work area will be implemented (see 3.2.3 Water Quality, Appendix 6 Runoff and Sediment Control Procedures).

e). Except where necessary to gain access to the work areas downstream of the Alouette dam, all new roads will be kept a minimum of 10 metres away from the river banks. No new road construction will occur downstream of the outlet of the Low Level Outlet extension.

f). Roads and work areas will be constructed of granular material, containing sufficient fines to act as binders. Material placed in the Alouette River channel to gain access to the work areas will be clean rock fill surfaced with road mulch.

g). Cut and fill slopes will be protected from erosion as specified in the Runoff and Sediment Control Procedures (Appendix 6). Erosion control measures will be implemented as early as possible during the construction phases and rehabilitation measures will be initiated during the construction phases. Drainage ditches will be designed and constructed so as to be erosion resistant. This will ensure that the environmental protection devices are in place and serviceable by the onset of heavier seasonal rainfalls in October.

h). Topsoil removed during site road construction will be stockpiled for use during rehabilitation of disturbed areas. Areas where topsoil will be used are specified in Appendix 7 and 9.

i). The first stage of the upstream cofferdam across the spillway apron, to facilitate access to the right bank of the spillway, will be constructed during 1991 when reservoir levels are low. This will enable construction to occur in the dry.

* j). The section of the proposed left bank access road along the river bank will be retained following the project to minimize further disturbance. Vegetation will be introduced along the river bank as shown in Appendix 9.

Construction Access

The impacts of construction traffic on the local community and on Golden Ears Provincial Park have been discussed with Maple Ridge Municipality, the local community, and the Ministry of Parks. An Open House was held in Maple Ridge on July 23, 1990 at which time proposals to minimize impacts were presented to the public.

In order to minimize the impact on any single route it is proposed (pending use agreements with the Ministry of Forests and private land owners for parts of Stevens Road) that the three routes will be utilized in the following manner:

a). 256th Street and Stevens Road. This route will be used by loaded vehicles accessing the work site. The use of local gravel pits will be encouraged to minimize truck traffic on 256th street.

b). 248th Street and the B.C. Hydro road. This will serve as the return route for the majority of time although it could be used by loaded vehicles at certain times.

c). 232nd Street, Fern Crescent, and the Golden Ears Park road. This route will be used by construction workers, and for limited construction materials during the period 12 November to 1 March. During the site preparatory work in 1991 some occasional use outside of this period may be required until the access across the upstream cofferdam is in place.

Arrangements for snow ploughing of park roads will be required. The Ministry of Parks will not permit use of salt for deicing park roads.

Recreational Use of Access Roads

During the project signs will be installed warning recreational users of the hazards associated with use of Stevens road and the B.C. Hydro access road while they are being used for construction traffic.

The Fraser Valley Endurance Riders have organized their annual two day endurance race for the long weekend in May 1992. It is planned that construction traffic will not use Stevens Road or the B.C. Hydro road on Saturday and Sunday of the race weekend.

Construction Parking

The utilization of the overflow parking area as a parking area for construction workers can be mitigated. During the project, part of the parking lot will be fenced off for use as a construction staging access area. The remaining portion will be used for construction parking but will be available, if necessary, as overflow parking for park visitors on Sundays and Statutory holidays during the peak recreational use period, June 15 to September 15. If Sunday shifts are necessary, construction workers will be directed to park on the east side of the dam.

B.C. Hydro will provide security staff to control access to and from the construction parking areas.

A plan specifying these arrangements is included in Appendix 10.

3.2.6 Reduced Reservoir Operating Levels

Reservoir water levels will be lowered as discussed earlier in Section 3.1.6. Problems associated with the reduced water levels will be addressed as follows:

a). Discharges from the LLO will be monitored to ensure that the reduced head does not result in reduced water flows. Gate adjustments will be made as necessary to ensure a discharge of approximately 0.57 m^3/sec. (20 cfs).

b). Water temperature will be monitored to ensure that it does not exceed 19°C at the 232nd Street Bridge. When excessive water temperatures are observed, flows will be increased. Up to 0.28 m^3/sec. additional flow can be released through the diversion for this purpose.

c). Fish spawning success within the reservoir is likely to be largely unaffected by drawdowns although winter levels will be below normal for dam safety. The reservoir will reach its winter maximum before October 1 as in the past

however, levels will depend on reservoir inflow. This is well in advance of the start of kokanee spawning in November and December (Knight 1987). Drawdown beyond this level will vary with requirements for power production and or precipitation.

The impact of reduced reservoir levels on the day-use beach in Golden Ears Park has been addressed by the placement of approximately 2,400 m^3 of sand. In order to provide the same opportunity for public use and enjoyment of the beach at El. 122.5 m that exists when the reservoir levels are near 124 m, the sand beach has been extended down to 121 m along the 300 m breadth. This has provided a wetted beach to a depth of 1.5 m when reservoir levels are at 122.5 m. During the summer of 1992 the IMNR level is proposed to be 121.5. Since this will provide a wetted beach of only 0.5 m further mitigation options will be reviewed with the Ministry of Parks prior to the spring of 1992.

Prior to placing the sand on the day-use beach, it was necessary to remove a large number of stones that cover the beach at the lower elevations. The stones have been used to channel the creek at the west end of the beach and to construct low rock groins to retard future loss of beach material.

The Camper's beach was extended by resloping the reservoir banks. prior to placing additional sand. The banks were over steepened and reducing the slope has enhanced public use as well as providing the necessary beach material.

The work was undertaken in the spring of 1990 when reservoir levels were below 121 m and was completed before April when reservoir levels began rising to summer operating levels. Funding was provided by B.C. Hydro and the work directed by the Ministry of Parks.

B.C. Hydro has provided public notice signs explaining the need to maintain reduced reservoir levels until the spillway rehabilitation work is complete. The information provided to the public contains a toll free project information number.

3.2.7 Noise, Dust, Public Safety and Security

All diesel and gasoline powered equipment will be equipped with appropriate mufflers in good repair. The use of electric powered de-watering pumps will greatly assist in the reduction of noise, particularly during the night when disturbance in the Provincial Park campground will be the most significant impact.

The control of dust generated by construction traffic can be achieved with the application of water or other dust suppressants. Only products approved by the Ministry of Environment will be used. These products include calcium lignosulphonate and sodium lignosulphonate. A new product named "Entac" may be used, however, approval is contingent on the

supplier, Entac Western Industries Inc., advising the Regional Director of the Ministry of Environment prior to application. The Ministry may choose to monitor the use of "Entac" if necessary.

Safety/security fences will be constructed to exclude the public from hazardous areas. Where the potential for injury is great, warning signs and, if necessary, security patrols will also be utilized. On-site security will be provided to ensure that the integrity of environmental protection measures is not jeopardized through acts of vandalism. Specifications for security and safety are contained in Appendix 10.

4.0 ENVIRONMENTAL MONITORING AND INSPECTION PROGRAM

4.1 Monitoring

A formal environmental monitoring program will be developed and implemented prior to the start of construction. During the construction phase, it will focus on minimizing the impact of the spillway rehabilitation project. Later, during site restoration, the inspectors will ensure that mitigation plans are successfully implemented.

4.1.1 Construction Monitoring

During construction, an environmental inspector will be on site during all work and will be responsible for the parameters shown in Table 5, plus general site inspections. Any deviations from the specified environmental management plan will be noted in daily written reports which will be copied to the Construction Manager (PIC) and BCH Environmental Resources. Causes of significant emissions of silt or oil spills will also be noted and reported as specified in the Spill Contingency Plan. The Construction Manager will implement corrective measures or spill plans as necessary.

Table 5
Construction Monitoring

Parameter	Frequency of inspection
Integrity and effectiveness of runoff and sediment control procedures	daily
Fuel storage and rain accumulations	daily
Equipment: oil and fuel security	daily
Water quality: dissolved oxygen, temperature, pH, and settleable solids	daily *
Adherence to Environmental Management Plan	daily
Oil Spill Contingency Equipment	monthly

* During periods of heavy rainfall or during environmentally sensitive work the frequency of water sampling will increase as required.

Sampling Locations

Water samples will be taken at three locations in Alouette Lake (upstream and downstream of the surface runoff disposal site and immediately upstream of the low level outlet) to establish background levels and to monitor dispersal and dilution of sediment at the surface water disposal site. Samples will be collected at the upstream sample site only when the surface water disposal system is activated. Lake samples will be collected with a Van Dorn water sample bottle. All samples will be analyzed for turbidity and selected samples for total suspended solids to establish a correlation between suspended solids and turbidity.

Water sampling will be conducted at the discharge of the low level outlet extension. This sample site will be used to establish the background level for the project unless problems with the surface water disposal site in the reservoir develop. Under these circumstances the upstream site in the reservoir will be used. Water samples at the discharge of the LLO will be analyzed for total suspended solids, turbidity, and temperature.

Water quality will be monitored a short distance downstream from the low level outlet extension. Total suspended solids,temperature, gas saturation and pH will be measured routinely. Turbidity will be measured with a continuous turbidity meter. Water flows will be measured at periodic intervals immediately downstream of the low level outlet extension to establish a discharge curve for staff gauge readings.

Water temperature and flows will be monitored regularly at the Water Survey of Canada gauge located at the 232nd Street bridge.

Miscellaneous sampling of water quality will be done to monitor the effect of the discharge from the dewatering wells.

In addition to the parameters specified in Table 5, the Environmental Inspector will be responsible for the following:

a). Maintenance of an accurate and current List of Contacts. (see Appendix 4).

b). Attendance at regular meetings involving B.C. Hydro, contractors and, if appropriate, environmental agency personnel.

c). Identification and reporting of emerging environmental issues.

4.1.2 Restoration Monitoring

During the restoration phase, Environmental Inspectors will ensure that all of the measures outlined in the Environmental Management Plan are successfully implemented so that the site is left in good condition. In addition, the Environmental Inspector will continue to monitor the parameters outlined in Table 5 until all construction/restoration activities are complete and the site has been vacated by all construction personnel and machinery.

4.1.3 Post Project Monitoring

Following completion of the project, including the completion of environmental restoration work, environmental monitoring will be the responsibility of the Fish and Water Resources Department and the Land and Social Resources Department. These departments of Environmental Resources will ensure that the fish, water, and recreational mitigation measures have been successful and will consult directly with the appropriate agencies on these matters.

REFERENCES

American Public Health Association (APHA). 1989. Standard methods for examination of water and wastewater. 17th edition.

B.C. Ministry of Parks. Parks Data Handbook - 1988.

Ballantyne, Aidan and Lougheed, Doug N. "The New Environmental Monitor". BioLine, Vol.9 No.1. 4 p.

Canadian Council of Resource and Environt Ministries (CCREM) 1987. Canadian Water Quality Guidelines.

Davis, J.C. Minimal disolved Oxygen requirements of Aquatic Life with emphasis on Canadian Species: a review. Canadian Journal of Fish Recources Bd. 32: 2295 - 2332.

Environmental Protection Agency (EPA). 1989. EPA Method 6020. Issue CLP- M, Version: 4.0.

Hancock, M.J. and D.E. Marshall. 1985. Catalogue of salmon streams and spawning escapements of Statistical Area 29, New Westminster Subdistrict. Can. Data. Rept. Fish. Aquat. Sci. No. 495. 90 p.

Faachin, A. and P.A. Slaney. 1977. Management Implications of substrate utilization during summer by juvenile steelhead trout Salmo gairdneri in the South Alouette River. M.R.C. Fish. Wildl Br., Fish. Tech. Circ. No. 32. 10 p.

Knight, R. 1986. Alouette lake Sport fishery. MOE, Fish and Wildlife Branch, Regional Fish. Rept. LM118 30 p.

Slaney, T.L. 1989. Fisheries enhancement opportunities in reservoirs of the British Columbia lower mainland. Prep. by Aquatic Resources Ltd. for B.C. Hydro. 53 p.

Sigma Environmental Consultants Ltd. 1983. Summary of water quality requirements for salmonid hatcheries. prep. for Dept. Fish. Oceans. 166 p.

APPENDICES

APPENDIX 1	1989/90 Water Quality Observations.
APPENDIX 2	Preliminary Spill Contingency Plan
APPENDIX 3	Reservoir Spill Contingency Plan
APPENDIX 4	List of Contacts
APPENDIX 5	Aquatic Habitay Survey and Restoration Plans
APPENDIX 6	Runoff and Sediment Control Procedures
APPENDIX 7	Spoil Area Rehabilitation Plan
APPENDIX 8	Access Location and Rehabilitation Plan
APPENDIX 9	Clearing and Excavation Rehabilitation Plan
APPENDIX 10	Public Safety, Security and Parking Plan

Appendix 1: 1989/90 WATER QUALITY OBSERVATIONS

CONTENTS

1989/90 Water Quality Observations	A1-2
Results of Analysis	A1-3 - A1-21

Appendix 1: 1989/90 WATER QUALITY OBSERVATIONS

Samples were taken approximately twice per week at the following stations:

1. Low Level Outlet (or extension pipeline)
2. Alouette River 20 m downstream of the pipeline outlet.
3. Alouette River just upstream of Mud Creek.
4. Alouette River 5 m below Mud Creek confluence.
5. Alouette River at the lip of the plunge pool.

Samples were taken during the well tests at the start of the test, after 24 hours and after 48 hours.

Samples were collected in clean PVC bottles. They were kept cool and delivered the same day to Power Tech Labs Inc. in Surrey B.C. The Samples were analyzed for general parameters in accordance with APHA 1985 and for metals in accordance with EPA 1989.

Results of the analysis follow overleaf.

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POWERTECH LABS INC.
12388 - 88th Avenue
Surrey, British Columbia
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Phone (604) 590-7500
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6 February 1990
Project: 0663-45-06
File: E140 C1
Work Order No.: 89522
89523
89524
89625
90500

Mr. H. Smith
B.C. Hydro - Corporate Affairs
Environmental Resources
1312 - 808 Nelson St.
Vancouver, B.C.
V6Z 2H2

Attention: Mr. Mark Johnston

Dear Sir:

Re: WATER SAMPLES
Alouette Lake Spillway Project - December 1989

Eight water samples, representing two sampling sites were submitted for analysis in December 1989. The sampling dates and site identifications are shown in the Table of Results.

Method of analysis

The samples were analysed for General Parameters in accordance with:

"Standard Methods for the Examination of Water and Wastewater", 16th Edition(1985), published by the American Public Health Association."

Total Metals were determined by ICP/MS in accordance with:

"EPA Method 6020" Issue CLP-M, Version: 4.0, dated May 3rd 1989. (CLP = Certified Laboratory Program)

Results of Analysis

The results are presented in the Table(s) of Results attached.

Prepared by: Carol McDonald
C. M. McDonald
Chemical Technologist

Approved by: W. R. Dinsmore
W. R. Dinsmore
Manager,
Environmental Sciences

cc: Tim Slaney
Aquatic Resources
CL453

TABLE OF RESULTS
ALOUETTE LAKE SPILLWAY PROJECT
SITE 1

Project: 0663-45-06
File: E140 C1
Work Order: 89522, 523, 524, 527, 90500

GENERAL PARAMETERS	Dec.9 1989	Dec.11 1989	Dec.15 1989	Dec.20 1989	Dec.28 1989
pH	6.7	6.7	6.7	6.7	6.3
Tubidity (NTU)	0.9	1.0	0.7	0.7	0.6
Specific Conductivity (umhos/25°C)	16	16	16	14	21
Total Suspended Solids (mg/L)	<1	<1	<1	<1	<1
Total Dissolved Solids (mg/L)	1	1	4	13	22
Calculated Hardness (mg $CaCO_3$/L)	4	3	11	8	8
Total Alkalinity (mg $CaCO_3$/L)	4	4	4	4	4
Nitrate (ug/L as N)	127	140	138	147	136
Nitrite (ug/L as N)	4	3	3	4	3
Sulfate (mg/L as SO_4^{-2})	2	2	2	2	<2
Total Phosphorous (ug/L as P)	6	5	5	4	8
TOTAL METALS (ug/L)					
Aluminum	74	54	52	50	44
Antimony	<0.1	0.5	<0.1	<0.1	0.1
Arsenic	1.9	1.2	0.5	0.2	0.3
Barium	2.4	20	41	47	41
Beryllium	<0.1	<0.1	<0.1	<0.1	<0.1
Boron	<2.1	<2.1	<6.6	<6.6	<6.6
Cadmium	<0.2	0.7	<0.1	<0.1	<0.1
Calcium	1200	1100	4000	2900	3100
Cobalt	<0.1	0.4	<0.1	0.1	0.1
Chromium	<0.2	1.1	1.1	1.1	0.5
Copper	<0.4	0.4	0.7	<0.4	<0.4
Potassium	160	180	280	170	210
Iron	42	38	120	66	73
Lead	<0.1	1.8	4	3.4	0.3
Magnesium	180	120	160	140	160
Manganese	4.5	3.1	4.0	4.8	6.3
Molybdenum	<0.2	<0.3	0.2	<0.1	<0.1
Nickel	<0.4	<0.4	<0.5	<0.5	<0.4
Selenium	1.1	1.1	1.0	<0.5	<0.5
Silver	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	610	450	8900	3200	2700
Zinc	1.1	13	4.8	2.0	1.6

TABLE OF RESULTS
ALOUETTE LAKE SPILLWAY PROJECT
SITE 2

Project: 0663-45-06
File: E140 C1
Work Order: 89522, 523, 524, 527, 90500

GENERAL PARAMETERS	Dec.9 1989	Dec.11 1989	Dec.15 1989	Dec.20 1989	Dec.28 1989
pH	6.9	6.7	6.7	6.9	6.5
Tubidity (NTU)	0.9	0.7	0.8	0.7	0.7
Specific Conductivity (umhos/25°C)	16	14	17	17	17
Total Suspended Solids (mg/L)	<1	<1	<1	<1	<1
Total Dissolved Solids (mg/L)	<1	11	14	25	23
Calculated Hardness (mg $CaCO_3$/L)	5	4	13	13	11
Total Alkalinity (mg $CaCO_3$/L)	5	4	5	5	4
Nitrate (ug/L as N)	134	135	134	141	131
Nitrite (ug/L as N)	7	4	4	5	3
Sulfate (mg/L as SO_4^{-2})	2	2	2	2	<2
Total Phosphorous (ug/L as P)	7	5	5	4	8
TOTAL METALS (ug/L)					
Aluminum	73	49	54	51	46
Antimony	0.3	<0.1	<0.1	<0.1	<0.1
Arsenic	0.5	<0.1	0.2	0.5	0.5
Barium	2.7	27	62	44	41
Beryllium	<0.1	<0.1	<0.1	<0.1	<0.1
Boron	<2.1	<2.1	<6.6	<6.6	<6.6
Cadmium	<0.2	<0.2	<0.1	<0.1	<0.1
Calcium	1600	1400	4700	4800	4200
Cobalt	<0.1	<0.1	<0.1	<0.1	0.1
Chromium	<0.2	<0.2	1.7	1.8	0.7
Copper	<0.4	<0.4	1.0	<0.4	<0.4
Potassium	230	200	260	280	210
Iron	52	31	77	100	80
Lead	<0.1	0.3	4.8	5.2	0.2
Magnesium	240	200	210	230	210
Manganese	4.7	4.4	5.1	6.8	9.3
Molybdenum	<0.2	<0.2	0.2	0.3	0.2
Nickel	<0.4	<0.4	<0.5	<0.5	<0.4
Selenium	3.7	1.1	<0.5	<0.5	1.9
Silver	<0.1	<0.1	<0.1	0.1	<0.1
Sodium	890	700	2800	1300	9200
Zinc	0.4	1.0	4.9	2.3	1.1

TABLE OF RESULTS
ALOUETTE LAKE SPILLWAY PROJECT
SITE 5

Project: 0663-45-06
File: E140 C1
Work Order: 90500

GENERAL PARAMETERS	Dec.28 1989	Ref. Std.	Advisory Range
pH	6.6	9.2	8.9-9.3
Tubidity (NTU)	0.7		
Specific Conductivity (umhos/25°C)	16	1712	1540-1880
Total Suspended Solids (mg/L)	<1	60	59-99
Total Dissolved Solids (mg/L)	17	1548	1520-1860
Calculated Hardness (mg $CaCO_3$/L)	10		
Total Alkalinity (mg $CaCO_3$/L)	6	187	169-199
Nitrate (ug/L as N)	130	4.9	4.4-5.4
Nitrite (ug/L as N)	3		
Sulfate (mg/L as SO_4^{-2})	<2	330	274-458
Total Phosphorous (ug/L as P)	7	4500	4100-4900
TOTAL METALS (ug/L)			
Aluminum	39		
Antimony	<0.1	160	93-155
Arsenic	0.3	52	44-74
Barium	40	190	147-245
Beryllium	<0.1	54	38-62
Boron	<6.6		
Cadmium	<0.1	98	65-109
Calcium	3600		
Cobalt	0.1	100	90-150
Chromium	0.6	190	169-282
Copper	<0.4	120	100-166
Potassium	180		
Iron	69	150	128-214
Lead	0.1	110	80-134
Magnesium	190		
Manganese	8.7	140	120-200
Molybdenum	0.2	74	78-130
Nickel	<0.4	260	234-390
Selenium	<0.5	67	47-78
Silver	<0.1		
Sodium	6400		
Zinc	0.6	130	94-158

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Mr. H. Smith
B.C. Hydro - Corporate Affairs
Environmental Resources
1312 - 808 Nelson St.
Vancouver, B.C.
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26 February 1990
Project: 0663-45-06
File: E140 C1

Work Order No.: 90501, 90503
90505, 90508
90510, 90513
90515, 90516

Attention: Mr Mark Johnston

Dear Sir:

Re: WATER SAMPLES - Alouette Lake Spillway Project January 1990

Eighteen water samples, representing three sampling sites were submitted for analysis in January 1990. The sampling dates and site identifications are shown in the Table of Results.

Method of Analysis

The samples were analysed for General Parameters in accordance with:

"Standard Methods for the Examination of Water and Wastewater 16th Edition (1985), published by the American Public Health Association."

Total Metals were determined by ICP/MS in accordance with:

"EPA Method 6020" Issue CLP-M, Version : 4.0, dated May 3rd 1989.
(CLP = Certified Laboratory Program)

Results of Analysis

The results are presented in the Table(s) of Results attached.

Prepared by: Carl McDonald
C.M. McDonald
Chemical Technologist

Approved by: W R Dinsmore
W.R. Dinsmore
Manager,
Environmental Sciences

cc: Tim Slaney
Aquatic Resources
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TABLE OF RESULTS
ALOUETTE LAKE SPILLWAY PROJECT
SITE 1

Project: 0663-45-06
File: E140 C1
Work Order: 90501, 90503, 90505, 90508

GENERAL PARAMETERS	Jan.3 1990	Jan.8 1990	Jan.12 1990	Jan.15 1990
pH	6.4	6.4	6.4	6.6
Tubidity (NTU)	0.7	0.7	1.4	0.7
Specific Conductivity (umhos/25°C)	14	17	15	14
Total Suspended Solids (mg/L)	<1	<1	1	<1
Total Dissolved Solids (mg/L)	18	23	27	20
Calculated Hardness (mg $CaCO_3$/L)	8	5	2	3
Total Alkalinity (mg $CaCO_3$/L)	4	4	4	4
Nitrate (ug/L as N)	135	140	136	140
Nitrite (ug/L as N)	3	<5	<5	<5
Sulfate (mg/L as SO_4^{-2})	1	2	2	2
Total Phosphorous (ug/L as P)	8	5	10	7
TOTAL METALS (ug/L)				
Aluminum	45	27	55	21
Antimony	0.1	0.1	0.1	0.5
Arsenic	<0.1	0.2	<0.1	<0.1
Barium	23	53	31	47
Beryllium	<0.1	<0.1	<0.1	0.2
Boron	<6.6	8.1	13	7.7
Cadmium	<0.1	<0.2	<0.2	<0.2
Calcium	2900	1700	710	1020
Cobalt	0.1	<0.1	<0.1	<0.3
Chromium	0.9	0.6	0.3	<0.6
Copper	<0.4	<0.4	<3.6	<0.4
Potassium	190	290	220	150
Iron	100	69	77	16
Lead	0.5	<0.1	1.8	<0.1
Magnesium	160	170	170	160
Manganese	8.4	5.9	7.4	5.7
Molybdenum	<0.1	0.3	0.3	0.2
Nickel	<0.5	0.3	<0.3	<2.9
Selenium	1.4	<0.6	<0.6	<1
Silver	<0.1	<0.1	<0.1	<0.1
Sodium	4000	720	650	220
Zinc	3.4	2.4	9.7	0.9

TABLE OF RESULTS
ALOUETTE LAKE SPILLWAY PROJECT
SITE 1

Project: 0663-45-06
File: E140 C1
Work Order:90510, 90513, 90515, 90516

GENERAL PARAMETERS	Jan.18 1990	Jan.23 1990	Jan.26 1990	Jan.30 1990
pH	6.5	6.4	6.4	6.5
Tubidity (NTU)	0.6	0.9	0.6	0.7
Specific Conductivity (umhos/25°C)	19	13	13	13
Total Suspended Solids (mg/L)	<1	<1	<1	<1
Total Dissolved Solids (mg/L)	25	21	18	17
Calculated Hardness (mg $CaCO_3$/L)	3	4	4	4
Total Alkalinity (mg $CaCO_3$/L)	4	4	4	3
Nitrate (ug/L as N)	133	155	147	142
Nitrite (ug/L as N)	<5	<5	<5	<5
Sulfate (mg/L as SO_4^{-2})	2	2	2	2
Total Phosphorous (ug/L as P)	<3	3	5	5
TOTAL METALS (ug/L)				
Aluminum	25	46	24	71
Antimony	0.7	<0.1	0.2	0.1
Arsenic	0.9	1.7	<0.1	0.2
Barium	47	41	41	36
Beryllium	0.3	0.2	<1	<0.1
Boron	14	17	19	7.5
Cadmium	<0.2	<0.3	<0.3	0.2
Calcium	1030	1500	1200	1300
Cobalt	<0.3	<0.3	<0.3	0.2
Chromium	<0.6	<0.6	<0.6	<0.3
Copper	<0.4	<0.4	1.1	2.1
Potassium	190	220	340	130
Iron	28	4.7	<2.8	96
Lead	0.8	0.2	1.9	<0.2
Magnesium	150	170	160	170
Manganese	6.7	6.6	7	9.6
Molybdenum	<0.2	<0.2	<0.1	<0.1
Nickel	<3	15	<0.3	<0.4
Selenium	<1	<0.1	2.9	2.9
Silver	<0.1	<0.1	<0.1	<0.1
Sodium	15	2300	2300	490
Zinc	1.7	2.8	5.6	2.8

TABLE OF RESULTS
ALOUETTE LAKE SPILLWAY PROJECT
SITE 2

Project: 0663-45-06
File: E140 C1
Work Order: 90501, 90503, 90505, 90508

GENERAL PARAMETERS	Jan.3 1990	Jan.8 1990	Jan.12 1990	Jan.15 1990
pH	6.6	6.5	6.6	6.6
Tubidity (NTU)	0.7	0.8	1.6	0.7
Specific Conductivity (umhos/25°C)	17	17	15	15
Total Suspended Solids (mg/L)	<1	12	<1	<1
Total Dissolved Solids (mg/L)	17	31	28	23
Calculated Hardness (mg $CaCO_3$/L)	12	5	5	4
Total Alkalinity (mg $CaCO_3$/L)	5	5	6	5
Nitrate (ug/L as N)	139	137	127	139
Nitrite (ug/L as N)	3	<5	<5	<5
Sulfate (mg/L as SO_4^{-2})	1	2	2	2
Total Phosphorous (ug/L as P)	8	8	11	8
TOTAL METALS (ug/L)				
Aluminum	41	34	70	23
Antimony	0.1	0.1	0.1	<0.1
Arsenic	0.2	<0.1	<0.1	<0.1
Barium	25	42	34	34
Beryllium	<0.1	<0.1	<0.1	<0.1
Boron	<6.6	13	12	8.3
Cadmium	<0.1	<0.2	<0.2	<0.2
Calcium	4300	1600	1400	1350
Cobalt	0.1	<0.1	<0.1	<0.3
Chromium	1.1	0.4	0.3	<0.6
Copper	<0.4	<2.8	<1.8	0.5
Potassium	240	240	230	180
Iron	100	62	110	8.3
Lead	0.2	0.4	0.3	0.4
Magnesium	220	220	250	210
Manganese	8.9	9.5	10	7.1
Molybdenum	<0.1	0.1	0.1	0.3
Nickel	<0.5	0.3	<0.3	<2.9
Selenium	0.5	<0.6	<0.6	<1
Silver	<0.1	<0.1	<0.2	<0.1
Sodium	7400	1100	1100	91
Zinc	1.9	4	1.8	2

TABLE OF RESULTS
ALOUETTE LAKE SPILLWAY PROJECT
SITE 2

Project: 0663-45-06
File: E140 C1
Work Orders: 90510, 90513, 90515, 90516

GENERAL PARAMETERS	Jan.18 1990	Jan.23 1990	Jan.26 1990	Jan.30 1990
pH	6.7	6.6	6.7	6.7
Tubidity (NTU)	0.6	1.0	0.8	1.0
Specific Conductivity (umhos/25°C)	17	16	17	17
Total Suspended Solids (mg/L)	<1	<1	<1	5
Total Dissolved Solids (mg/L)	11	31	20	1
Calculated Hardness (mg $CaCO_3$/L)	4	5	6	6
Total Alkalinity (mg $CaCO_3$/L)	5	5	5	6
Nitrate (ug/L as N)	129	154	149	142
Nitrite (ug/L as N)	<5	<5	<5	<5
Sulfate (mg/L as SO_4^{-2})	2	2	2	2
Total Phosphorous (ug/L as P)	<3	6	4	9
TOTAL METALS (ug/L)				
Aluminum	14	56	32	120
Antimony	<0.1	<0.1	0.5	<0.1
Arsenic	2.2	1.2	<0.1	<0.2
Barium	34	36	14	41
Beryllium	0.1	0.1	<0.1	<0.1
Boron	4.2	13	18	6
Cadmium	<0.2	<0.3	<0.3	<0.1
Calcium	1300	1750	2200	2000
Cobalt	<0.3	<0.3	<0.3	<0.1
Chromium	<0.6	<0.6	<0.6	0.4
Copper	<0.4	<0.4	<0.4	<0.4
Potassium	180	260	420	200
Iron	8.6	<2.8	23	150
Lead	<0.2	0.3	0.8	<0.2
Magnesium	200	230	250	250
Manganese	6.6	6.9	8.7	13
Molybdenum	<0.2	<0.2	0.2	<0.1
Nickel	<0.7	6.4	4.1	1.8
Selenium	<1.0	<0.1	<1.0	<0.4
Silver	<0.1	<0.1	<0.1	<0.1
Sodium	220	1400	2300	670
Zinc	<0.4	1.5	2.6	1.8

TABLE OF RESULTS
ALOUETTE LAKE SPILLWAY PROJECT
SITE 5

Project: 0663-45-06
File: E140 C1
Work Orders: 90505, 90515

GENERAL PARAMETERS	Jan.12 1990	Jan.26 1990	Ref. Std.	Advisory range
pH	6.5	6.8	9.0	8.9-9.3
Tubidity (NTU)	2	0.8		
Specific Conductivity (umhos/25°C)	23	18	1702	1540-1880
Total Suspended Solids (mg/L)	2	<1	73	67-111
Total Dissolved Solids (mg/L)	34	17	1679	1520-1860
Calculated Hardness (mg $CaCO_3$/L)	4	5		
Total Alkalinity (mg $CaCO_3$/L)	5	5	186	169-199
Nitrate (ug/L as N)	129	147	3.3	3.7-4.7
Nitrite (ug/L as N)	<5	<5		
Sulfate (mg/L as SO_4^{-2})	2	2	331	320-390
Total Phosphorous (ug/L as P)	11	6	7	6.2-7.6
TOTAL METALS (ug/L)				
Aluminum	65	32	99	88-146
Antimony	0.2	<0.1	140	63-106
Arsenic	<0.1	1.5	100	98-164
Barium	35	40	75	122-202
Beryllium	<0.1	<0.1	61	41-69
Boron	14	16		
Cadmium	<0.2	<0.3	71	40-68
Calcium	990	1600		
Cobal	<0.1	<0.3	220	152-254
Chromium	0.3	<0.6	250	192-321
Copper	<0.4	<0.4	110	74-123
Potassium	250	450		
Iron	110	20	220	170-282
Lead	0.2	0.7	150	115-192
Magnesium	240	240		
Manganese	8.6	8.2	210	154-256
Molybdenum	0.1	0.5	100	67-112
Nickel	<0.3	3.3	120	98-164
Selenium	<0.6	2.1	110	61-102
Silver	<0.1	<0.1	33	21-65
Sodium	890	1600		
Zinc	<0.4	1.8	220	141-235

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Mr. H.A. Smith
B.C. Hydro - Corporate Affairs
Environmental Resources
1312-808 Nelson St.
Vancouver, B.C.

2 April 1990
Project: 0663-45-06
File: E140 C1
Work Order No.: 90517, 90518
90519, 90520
90521, 90524
90526

Attention: Mr. Mark Johnston

Dear Sir:

Re: Water Samples - Alouette Lake Spillway Project
February 1990

Eighteen water samples, representing three sampling sites were submitted for analysis in January 1990. The sampling dates and site identifications are shown in the Table of Results.

Method of Analysis

The samples were analysed for General Parameters in accordance with:

"Standard Methods for the Examination of Water and Wastewater", 17th Edition (1989), published by the American Public Health Association.

Total Metals were determined by ICP/MS in accordance with:

"EPA Method 6010" Issue CLP/M, Version: 4.0, dated May 3rd 1989.
(CLP = Certified Laboratory Program)

Results of Analysis

The results are presented in the Table(s) of Results attached.

Prepared by: _____
C. M. McDonald
Chemical Technologist

Approved by: _____
W. R. Dinsmore
Manager,
Environmental Sciences

cc: Tim Slaney
Aquatic Resources
CL567

TABLE OF RESULTS
ALOUETTE LAKE SPILLWAY PROJECT - SITE 1

Project: 0663-45-06
Work Order: 90517, 90518, 90519, 90520

GENERAL PARAMETERS	Feb.2 1990	Feb.6 1990	Feb.8 1990	Feb.12 1990
pH	6.5	6.5	6.8	6.6
Tubidity (NTU)	0.9	0.5	1.2	1.5
Specific Conductivity (umhos/25°C)	13	13	16	13
Total Suspended Solids (mg/L)	1	<1	<1	<1
Total Dissolved Solids (mg/L)	7	11	7	10
Calculated Hardness (mg $CaCO_3$/L)	4	4	5	4
Total Alkalinity (mg $CaCO_3$/L)	4	4	5	4
Nitrate (ug/L as N)	146	166	135	145
Nitrite (ug/L as N)	<5	<5	<5	<5
Sulfate (mg/L as SO_4^{-2})	2	2	2	3
Total Phosphorous (ug/L as P)	4	3	4	3
TOTAL METALS (ug/L)				
Aluminum	74	33	33	79
Antimony	<0.1	<0.1	<0.1	0.9
Arsenic	<0.2	<0.2	<0.6	0.2
Barium	39	44	35	49
Beryllium	<0.1	<0.1	<0.1	<0.1
Boron	8	6.3	8.8	2.9
Cadmium	<0.1	<0.1	<0.2	<0.1
Calcium	1400	1200	1600	1400
Cobalt	<0.1	<0.1	<0.1	0.1
Chromium	0.6	0.4	<0.3	0.7
Copper	<0.4	<0.4	<0.4	<0.4
Potassium	150	100	130	200
Iron	110	64	66	84
Lead	<0.2	<0.2	<0.2	0.2
Magnesium	170	150	220	150
Manganese	9.4	7.9	7.6	6.6
Molybdenum	<0.1	<0.1	<0.1	0.1
Nickel	0.9	0.1	1.4	<0.5
Selenium	6	5.4	7.3	<0.3
Silver	<0.1	0.1	<0.1	<0.1
Sodium	530	440	610	640
Zinc	<0.6	0.7	<0.5	5

TABLE OF RESULTS
ALOUETTE LAKE SPILLWAY PROJECT
SITE 2

Project: 0663-45-06

Work Order: 90517, 90518, 90519,90520

GENERAL PARAMETERS	Feb.2 1990	Feb.6 1990	Feb.8 1990	Feb.12 1990
pH	6.7	6.8	7	6.8
Tubidity (NTU)	1.4	0.9	1.2	2.8
Specific Conductivity (umhos/25°C)	17	16	20	17
Total Suspended Solids (mg/L)	8	1	<1	<1
Total Dissolved Solids (mg/L)	10	17	18	16
Calculated Hardness (mg $CaCO_3$/L)	6	6	7	5
Total Alkalinity (mg $CaCO_3$/L)	6	5	6	5
Nitrate (ug/L as N)	153	144	138	128
Nitrite (ug/L as N)	<5	<5	<5	<5
Sulfate (mg/L as SO_4^{-2})	2	2	2	3
Total Phosphorous (ug/L as P)	12	6	6	5
TOTAL METALS (ug/L)				
Aluminum	140	51	48	178
Antimony	1	0.4	<0.1	<0.1
Arsenic	0.9	<0.2	<0.2	<0.1
Barium	46	46	34	34
Beryllium	<0.1	<0.1	<0.1	<0.1
Boron	4.8	6.5	12	23
Cadmium	<0.1	<0.1	<0.1	<0.1
Calcium	1800	1800	2400	1700
Cobalt	0.1	0.5	<0.1	<0.1
Chromium	0.4	0.2	0.5	0.6
Copper	<0.4	<0.4	<0.4	<0.4
Potassium	170	160	240	230
Iron	160	78	81	94
Lead	<0.2	<0.2	<0.2	0.1
Magnesium	260	240	350	210
Manganese	12	8.5	10	6.6
Molybdenum	<0.1	<0.1	0.2	<0.1
Nickel	1.3	0.6	1.1	<0.5
Selenium	5	8.3	<2.7	0.7
Silver	<0.1	<0.1	<0.1	<0.3
Sodium	690	630	850	710
Zinc	<0.6	0.7	<0.5	0.9

TABLE OF RESULTS
ALOUETTE LAKE SPILLWAY PROJECT
SITE 5

Project: 0663-45-06

Work Order: 90518, 90520

GENERAL PARAMETERS	Feb.6 1990	Feb.12 1990	Ref. Std. (mg/L)*	Advisory Range (mg/L)*
pH	6.8	7.4	9.1	8.9-9.3
Tubidity (NTU)	1.3	10	0.8	0.6-1.0
Specific Conductivity (umhos/25°C)	16	44	2369	2090-2550
Total Suspended Solids (mg/L)	<1	2	80	67-111
Total Dissolved Solids (mg/L)	13	45	1589	1420-1740
Calculated Hardness (mg $CaCO_3$/L)	5	18	-	-
Total Alkalinity (mg $CaCO_3$/L)	6	20	182	169-199
Nitrate (ug/L as N)	153	137	4.6	3.7-4.7
Nitrite (ug/L as N)	<5	<5	-	-
Sulfate (mg/L as SO_4^{-2})	2	<2	333	320-390
Total Phosphorous (ug/L as P)	6	33	6.8	6.2-7.6
TOTAL METALS (ug/L)				
Aluminum	37	600	300	216-360
Antimony	0.3	<0.9	120	84-140
Arsenic	<0.2	0.1	130	100-168
Barium	60	50	43	44
Beryllium	<0.1	<0.1	42	24-40
Boron	7.3	2.8	96	94
Cadmium	0.9	0.1	120	74-124
Calcium	1600	5600	-	-
Cobalt	0.1	0.3	110	73-122
Chromium	<0.3	1.3	770	499-831
Copper	<0.4	<0.4	140	98-164
Potassium	160	830	-	-
Iron	80	460	140	99
Lead	<0.2	0.2	24	23.7
Magnesium	230	910	-	-
Manganese	8.8	23	310	197-329
Molybdenum	<0.1	0.4	180	121-202
Nickel	0.8	<0.5	80	59-99
Selenium	6	1.1	8.2	9.7
Silver	<0.1	<0.1	15	10-40
Sodium	610	1900	-	-
Zinc	<0.6	1.5	560	520-888

* Except pH, turbidity and specific conductivity units which are as noted under General Parameters.

TABLE OF RESULTS
ALOUETTE LAKE SPILLWAY PROJECT

Project: 0663-45-06
Work Order No.: 90521
90524
90526

Total Suspended Solids
(mg/L)

	Feb.17 1990	Feb.19 1990	Feb.22 1990	Feb.27 1990
Site 1	<1	12	<1	2.4
Site 2	<1	12	<1	4.5

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Mr. H. Smith
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20 April 1990
Project: 0663-45-06
File: E140 C1
Work Order: 90528, 90529
90531, 90533
90535, 90536
90537, 90538
90540, 90541

Attention: Mr. Mark Johnston

Dear Sir:

Re: WATER SAMPLES - ALOUETTE LAKE SPILLWAY PROJECT
MARCH 1990

Twenty-one water samples, representing six sampling sites were submitted for analysis in March 1990. The sampling dates and site identifications are shown in the Table of Results.

METHOD OF ANALYSIS

The samples were analysed for General Parameters and Total Metals in accordance with:

"Standard Methods for the Examination of Water and Wastewater", 17th Edition (1989), published by the American Public Health Association".

RESULTS OF ANALYSIS

The results are presented in the Table(s) of Results attached.

Prepared by: Carol McDonald
C. M. McDonald
Chemical Technologist

Approved by: W. R. Dinsmore
W. R. Dinsmore
Manager,
Environmental Sciences

cc: Tim Slaney
Aquatic Resources

CL603

TABLE OF RESULTS
ALOUETTE WELL

Project: 0663-45-06
Work Orders: 90536, 90537

GENERAL PARAMETERS	TO March 16 1990	T24 March 19 1990	T48 March 20 1990	Reference Standard Found	Reference Standard Advisory Range
pH	7.9	7.9	7.9	9.0	8.8-9.2
Turbidity (NTU)	1.2	0.5	0.4	0.8	0.6-1.0
Colour (APHA)	<5	<5	<5		
Specific Conductivity (umhos/25°C)	123	139	150	2320	2090-2550
Total Suspended Solids (mg/L)	<1	<1	<1	79	59-99
Total Dissolved Solids (mg/L)	73	89	103	1690	1520-1860
Calculated Hardness (mg $CaCO_3$/L)	32	40	41	-	-
Total Alkalinity (mg $CaCO_3$/L)	57	68	73	145	133-147
Sulfate (mg/L as SO_4^{-2})	<2	<2	<2	355	320-390
Ammonia (ug/L as N)	33	35	35	10.5	10.3-13.7 (mg/L)
Total Phosphorous (ug/L as P)	15	13	15	340	310-380
TOTAL METALS					
Major (mg/L, ppm)					
Calcium	9.8	12.1	12.7	136	107-161
Magnesium	1.9	2.3	2.3	38	32-40
Trace (ug/L, ppb)					
Aluminum	100	<50	<50	0.50	0.31-0.51
Cadmium	<0.5	<0.5	<0.5	0.051	0.040-0.068
Copper	<1	<1	<1	0.100	0.740-0.123
Lead	<3	3	<3	0.150	0.110-0.190
Zinc	<50	<50	<50	0.701	0.520-0.888

TABLE OF RESULTS
ALOUETTE LAKE SPILLWAY PROJECT

Project: 0663-45-06
Work Order: 90528, 90529
90531, 90533
90535, 90538
90540, 90541

	MAR 2 1990	MAR 6 1990	MAR 9 1990	MAR 13 1990	MAR 15 1990	MAR 20 1990	MAR 23 1990	MAR 28 1990
TOTAL SUSPENDED SOLIDS (MG/L)								
SITE 1	<1	<1	1	<1	<1	<1	<1	<1
SITE 2	<1	1	1	<1	<1	1	<1	1.7
SITE 5		<1				<1		
TURBIDITY (NTU)								
SITE 1						0.9	2.5	0.5
SITE 2						0.9	2.5	0.8
SITE 3								0.5
SITE 4								0.6
SITE 5						1.3		0.8

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3 May 1990
Project: 0663-45-06
File: E140 C1
Work Order No.: 90542,90543
90544,90545
90546,90557
90558

Attention: Mr. Mark Johnston

Dear Sir:

Re: WATER SAMPLES - Alouette Lake Spillway Project
April - 1990

Thirty-five water samples, representing five sampling sites were submitted for analysis in April 1990. The sampling dates and site identifications are shown in the Table of Results.

Method of Analysis

The samples were analysed for Suspended Solids and Turbidity in accordance with:

"Standard Methods for the Examination of Water and Wastewater", 17th Edition (1989), published by the American Public Health Association.

Results of Analysis

The results are presented in the Table(s) of Results attached.

Prepared by: C. M. McDonald
C. M. McDonald
Chemical Technologist

Approved by: W. R. Dinsmore
W. R. Dinsmore
Manager,
Environmental Sciences

cc: Tim Slaney
Aquatic Resources

CL72

TABLE OF RESULTS
ALOUETTE LAKE SPILLWAY PROJECT

PROJECT:0663-45-06
WORK ORDER: 90542,90543
90544,90545
90546,90557
90558

	APR 1 1990	APR 4 1990	APR 6 1990	APR 9 1990	APR 10 1990	APR 18 1990	APR 20 1990
TOTAL SUSPENDED SOLIDS (MG/L)							
SITE 1	<1	<1	<1	40	2	1	2
SITE 2	<1	1	<1	7	4	1	4
SITE 5		<1					
TURBIDITY (NTU)							
SITE 1	0.4	0.5	0.4	6.5	1.8	0.6	0.7
SITE 2	0.5	0.7	0.5	4.0	1.8	0.5	0.9
SITE 3	0.5	0.4	0.4	0.5	1.1	0.4	0.6
SITE 4	0.5	0.9	2.8	6.0	1.2	1.5	5.5
SITE 5	0.6	1.0	0.7	0.6	0.8	0.5	0.4

Appendix 2: PRELIMINARY SPILL CONTINGENCY PLAN

An oil fuel and chemical Spill Contingency Plan will be developed for each aspect of the project.

A preliminary Spill Contingency Plan follows overleaf. The Spill Contingency plan contains specifications for the preventive measures to be implemented, details on spill response procedures and responsibilities and a list of equipment and materials that should be available. Also included is a telephone list of individuals to be contacted in the event of a spill and a spill notification form. Environmental Resources Standard ER-PC-03, which provides the basis for the specific spill response procedures is included as well.

ALOUETTE SPILLWAY REHABILITATION

PRELIMINARY SPILL CONTINGENCY PLAN

ALOUETTE SPILLWAY REHABILITATION

PRELIMINARY SPILL CONTINGENCY PLAN

CONTENTS

1.	PREVENTIVE MEASURES	A2-4
2.	SPILL RESPONSE, ACTION REQUIRED BY DESIGNATED PERSON IN CHARGE	A2-6
4.	EQUIPMENT AND MATERIALS	A2-8
5.	TELEPHONE LIST OF CONTACTS	A2-9
5.	NOTIFICATION OF HAZARDOUS MATERIALS SPILL	A2-11
6.	ENVIRONMENTAL RESOURCES STANDARD ER-WM-03	A2-12

ALOUETTE SPILLWAY REHABILITATION

PRELIMINARY SPILL CONTINGENCY PLAN

PREVENTIVE MEASURES

1. Spillway and Stilling Basin Excavation:

   - Oil containment booms deployed. (locations to be specified)
   - Drip containment facilities under stationary equipment and sorbent pads inspected and cleaned regularly.
   - Large tanks to have containment facilities capable of holding holding entire contents of tank.
   * - 45 gallon barrels c/w sealable lid on hand. 2 on site.
   * - Sorbent Pads: packages (200 sheets/package) on hand. 1 pkg sweeps, 1 pkg sheets on site.
   - An oil skimmer available on call (P. Roth 663-4184 after hours: 431-7007).

2. Fuel Storage/ site headquarters:

   - Fuel storage tanks to be equipped with imperviously lined containment basins.
   - Containment basins to be inspected and cleaned out daily.
   - Water collecting from rain to be removed daily.
   - Fuel transfers - No Smoking within 15 m.
   - Environmental inspector or designated person present during transfers.
   * - 45 gallon barrels c/w sealable lid on hand. 2 bung type, 2 open top on site.
   * - Sorbent Pads: 2 packages (200 sheets/package) reserve supply on hand.
   * - Sorbent booms: 2 packages (4x10 feet/package) reserve supply on hand.

3. Well Drilling Sites:

   - Drill sites to be contained by sand bag dykes, c/w impervious lining.

* revisions

- Drip containment facilities under equipment. Sorbent pads inspected daily and replaced as necessary.

- Fuel tanks to have containment facilities capable of holding entire contents of tank. Refueling only during day light hours only.

- One 45 gallon barrel c/w sealable lid at each drill rig.

- Sorbent Pads: 1 package (200 sheets) with each drill rig.

- Oil containment boom to be deployed in any adjacent water body or stream (plunge pool, drainage ditches etc.).

*

NOTE: 45 gallon barrels (6 open top and 6 bung type), sorbent pads (6 sweep and 6 sheet type) and sorbent booms (2 pkgs) should be stored at a central facility. These would then be used as required.

* revision

ALOUETTE SPILLWAY REHABILITATION

PRELIMINARY SPILL CONTINGENCY PLAN

SPILL RESPONSE - ACTION REQUIRED BY DESIGNATED PERSON IN CHARGE

If a pollutant (including but not limited to petroleum, fuel oil, sludge, oil refuse, or oil mixed with wastes, industrial chemicals or pesticides) is spilled into the Alouette Reservoir or into the Alouette River or onto adjacent areas from private or B.C. Hydro sources then the Construction Manager (PIC) shall:

1. Stop pollutant flow if possible.

2. Warn people in the immediate vicinity and take precautionary measures such as enforcing No Smoking and extinguishing any flame as applicable.

3. Contain spill by blocking off drains, culverts and ditches to prevent contaminants from entering water courses. Surround pollutant with earth, peat, straw, sand, booms or commercial sorbents. Spill containment and cleanup materials are available locally and are listed on page A2-8.

   Environmental Inspector to assist including sampling of water as required.

4. Obtain assistance. Assistance is available from:

   B.C. Hydro, Environmental Resources

   B.C. Hydro Production.

   Contractors on site.

5. NOTIFY:

   a) Project Manager(complete Notification form - A2-11).

   b) Provincial Emergency Program: A Ministry of Environment regulation, effective 10 August, 1990, makes spill reporting mandatory. Reports should be made by the person who had possesion, charge, or control of the substance before its spill (for the 24 hour telephone no. see page A2-9). Reportable amounts are as follows:

	SUBSTANCE SPILLED	REPORTABLE AMOUNT
* 1.	Flammable liquids, Class 3 (e.g. gasoline, alcohol, acetone)	100 litres

* revision

* *	2.	Corrosive liquids, Class 8 (e.g. caustics, acids)	5 kg or 5 litres
	3.	Miscellaneous products, Class 9.2 (includes PCBs and contaminated oil >50 ppm)	1 kg or 1 litre
	4.	Oil (and waste oil)	100 litres
	5.	Other substances (antifreeze)	200 litres

Reports may be made by telephone to the Provincial Emergency Program (1-800-663-3456) and shall include:

- the name and phone number of the person reporting the spill
- the name and phone number of the person causing the spill
- the location and time of the spill
- the type and quantity of the substance spilled
- the cause and effect of the spill
- details of the actions taken or proposed to contain the spill and minimize its effect
- the names of agencies on the scene
- the names of other persons or agencies advised

c) Medical Health Officer of Public Health Service.

d) Depending on the severity of the situation, obtain assistance from RCMP.

e) Environmental Resources:

Waste Management Department - will assess the nature and seriousness of the spill, and advise B.C. Hydro Press Liaison, the Provincial Ministry of Environment, Worker's Compensation, and Environment Canada, as necessary.

Environmental Inspector/Environmental Coordinator/Manager Fish and Water Resources - will advise the Provincial Ministry of Environment, Fish and Wildlife Branch and the Federal Department of Fisheries and Oceans, Ministry of Parks, Solicitor General - Alouette Corrections.

f) Production Department - Ruskin

6. Commence recovery , cleanup and restorative action. Advice and assistance with the cleanup and restoration measures are available from Environmental Resources including the obtaining of approval for waste material disposal from the Waste Management Branch, Ministry of Environment.

7. Refer also to the attached Environmental Resources Standard; ER-WM-03, SPILL RESPONSE (see pages A2-12 to A2-16).

* revision

ALOUETTE SPILLWAY REHABILITATION

PRELIMINARY SPILL CONTINGENCY PLAN

EQUIPMENT AND MATERIALS

The following equipment to be available on site as specified in Section 1 of the Spill Contingency Plan - Preventive Measures.

OIL SPILL CONTAINMENT BOOMS:

OIL SORBENT BOOMS:

available in packages (4 @ 10 feet/package)

OIL SORBENT PADS:

available in packages (200 sheets/package)

Additional containment booms, sorbent booms and pads are available from:

Versatech Products Inc.	Office:	420-7755
8070 Winston	Fax :	922-7745
Burnaby	After hours:	434-5600
		464-7857

BARRELS:

45 gal. barrels with sealable lids.

OIL SKIMMER:

Available from Environmental Resources - Waste Management Dept.

Andy Grikis	663-3351
Peter Roth	663-4184
(after hours)	431-7007

ALOUETTE SPILLWAY REHABILITATION

PRELIMINARY SPILL CONTINGENCY PLAN

TELEPHONE LIST OF CONTACTS

B.C. HYDRO

			Office
	ENVIRONMENTAL RESOURCES		
	Waste Management Department:		
	A. Grikis	- Manager Waste Management	663-3351
	P. Roth		663-4184
	A. Deaust		663-4390
	After hours		299-0311 or 431-7007
	Environmental Coordination		
*	C. Lamont	- Environmental Inspector	Cellular 649-3415
*			
*	D.R.J. Wilson	- Environmental Coord.	663-1804
	M.D. Johnston	-	663-2291
	H.A. Smith	- Manager Fish and Water	663-4481
	CONSTRUCTION MANAGEMENT:		
*	R.M. Ellis	- Construction Manager	663-3503
			Cellular 230-3638
*	E. Schroeder	- Construction Officer	
			Cellular 649-3415
	HYDRO FORCE CONSTRUCTION:		
*	E.G. Burroughs	- Site supervisor	597-5349
*			Cellular 671-0390
*	V.E. Boley	- Site Foreman	Cellular 671-5143
*			Cellular 649-2247
	R.J. Lockhart	- Project supervisor	597-5317
*			Cellular 657-3885
	W.W. Hicks	- H.F.C. Manager	597-5301
	PRODUCTION DEPARTMENT:		
	C.J. Morrison	- Production Spvr.	462-7145
	After hours	- LMC Dispatcher (24hr.)	430-8284
		- SCC Dispatcher (24hr.)	293-5821/32
	PROJECT MANAGEMENT/ENGINEERING		
	W.J. Brunner	- Project Manager	663-3042
	C.W. Holder	- Project Engineer	663-3730
	S.J. Garner	- Geotech. Engineer	663-2917

* Revision

GOVT. OF B.C.

	Ministry of Environment - Surrey	584-8822
	Provincial Emergency Program (24 hours)	1-800-663-3456
*	Ministry of Parks - Golden Ears Park	463-3513
	Solicitor General - Alouette Corrections	463-8891

GOVT. OF CANADA

	Department of Fisheries and Oceans	
*	Lee Dutta	666-3491
	Environment Canada	666-6100

* Revision

ALOUETTE SPILLWAY REHABILITATION

PRELIMINARY SPILL CONTINGENCY PLAN

NOTIFICATION OF HAZARDOUS MATERIALS SPILL

(To be issued within 24 hours)

TO: W.J. BRUNNER
PROJECT MANAGER
HO-10

DATE:

FROM: _____

FILE:

DATE OF OCCURENCE:

LOCATION:

DESCRIPTION OF PROBLEM:
(Type and Quantity of Substance Spilled)

PERSONS/AGENCIES NOTIFIED:

CAUSE AND EFFECT OF SPILL:

ACTION TAKEN:

FURTHER ACTION PROPOSED:

c.c. Director of Dam Safety & Deputy Chief Engineer
Managers of: Environmental Resources - Waste Management
Production Department
Hydroelectric Engineering Division
Security Services Department
System Operations and Maintenance Division

Title:	Subject:
ENVIRONMENTAL RESOURCES STANDARD	Spill Response
	Number: ER-WM-03

SUBJECT: SPILL RESPONSE

1.0 PURPOSE

To describe B.C. Hydro's response procedures in case of spills of hazardous materials, including oil, PCBs, mercury, caustics, acids, etc.

2.0 STANDARD PRACTICE

2.1 General

The general objective is to control and minimize environmental damage due to the spill. In this regard the order of priority in any spill response situation is to firstly ensure that the spill source is eliminated or secured. Containment, clean up, notification and reporting logically follow.

The following steps apply to all spills:

2.1.1 Stop product flow

Shut off pumps, valves, plug leaks, right containers, etc.

2.1.2 Warn people in area

Exercise discretion, warning may need to be extended to area residents. Implement cautionary measures such as NO SMOKING if spill is flammable.

2.1.3 Contain the spill

Block drains, culverts, ditches. Immobilize product with sorbents, earth, sand, straw, booms as available or as required.

2.1.4 Get help

Assistance is available within B.C. Hydro, and from others such as police, fire department, public works, contractors, etc.

2.1.5 Commence clean up

Procedures may vary depending on the product spilled. Technical assistance is available from ENVIRONMENTAL RESOURCES.

2.1.6 Notify the Ministry of Environment for spills that reach reportable amounts

Substance Spilled	Reportable Amount
1. Flammable liquids, Class 3	100 litres
2. Corrosive liquids, Class 8	5 kg or 5 litres
3. Miscellaneous products, Class 9.2 (includes PCBs and contaminated oil > 50 ppm)	1 kg or 1 litre
4. Oil (and waste oil)	100 litres
5. Other substances (antifreeze)	200 litres

NOTE: Spill reporting is mandatory further to a new regulation, dated 10 August 1990, under the Waste Management Act.

The person who had possession, charge, or control of a substance before its spill, shall immediately report the spill to PEP by phoning 1-800-663-3456 (24 hour number).

The report shall include:

- the name and phone number of the person reporting the spill
- the name and phone number of the person causing the spill
- the location and time of the spill
- the type and quantity of the substance spilled
- the cause and effect of the spill
- details of action taken or proposed to contain the spill and minimize its effect
- the names of agencies on the scene
- the names of other persons or agencies advised

2.1.7 Notify others as required

Normally B.C. Hydro Management must be advised of all spills, and B.C. Hydro Press Liaison if the nature of the spill is such that public concern may arise.

Environmental Resources can assist and provide spill response advice, but the initial report to the Ministry of Environment should be provided by the responsible Key Business Unit (KBU).

2.1.8 File written report

Normally a diary of events surrounding the incident will suffice.

2.1.9 Following is list of contacts:

PROVINCIAL EMERGENCY PROGRAM	Victoria, B.C.	1-800-663-3456 (24 hour)
ENVIRONMENTAL RESOURCES	Andy Grikis	663-3351
	Peter Roth	663-4184
	Angie Deaust	663-4390
	After Office Hours	229-0311 or 431-7007 (24 hour)
PRESS LIAISON	Peter McMullan	663-2409

2.2 Specific

The following sequence is recommended for distribution transformers:.

2.2.1 Ensure electrical safety

Disconnect, ground, etc.

2.2.2 Stop flow

Plug teaks, right tipped transformers.

2.2.3 Contain spill

Block drainage, immobilize oil with sorbents, sand, soil, or material as available.

2.2.4 Field test for PCBs

(i) Field test is negative

Remove damaged transformer to line room, pick up oil with sorbents, apply sorbents to driveways, roads to soak up excess oil, sweep up oily sorbent. If spill is on lawn, remove sod and replace grass. Removed material may be disposed of as garbage. Submit sample to Laboratory for confirmation analysis.

(ii) Field test is positive

Use protective coveralls, gloves. Place transformer in tray or drum, cover with plastic and remove to lineroom. Pick up oil with sorbents, apply sorbents to driveways, roads to soak up excess oil, sweep up oily sorbent. If spill is on lawn, remove sod and replace grass. Submit oil sample to Laboratory for confirmation analysis.

(iii) If PCB is less than 50 ppm

Removed material may be disposed of as garbage. No further clean up required.

(iv) If PCB is greater than 50 ppm

Excavate all visible oil stains. Collect all removed material in ring-top 45 gal. drums, or plastic bags, identify contents (date, site), and remove to storage. Take soil sample after clean up. This sample will determine if additional clean up is required.

2.2.5 Notify PEP at 1-800-663-3456 (24 hour) for spills of the following amounts:

Substance Spilled	Reportable Amount
PCB and contaminated oil > 50 ppm	1 kg or 1 litre
Oil	100 litres

It is important to note that in the case of a distribution transformer spill, the oil is considered to be PCB contaminated unless proven otherwise. This means that if the oil is known to be PCB free, only spills in excess of 100 litres must be reported. If unknown, spills in excess of 1 litre are reportable.

2.2.6 Notify ENVIRONMENTAL RESOURCES, Waste Management, of the nature, location and time of all spills so that a corporate-wide record may be compiled.

Appendix 3: RESERVOIR SPILL CONTINGENCY PLAN

A contingency plan to minimize the impacts of a reservoir spill during the project will be developed once on site personell have been determined. The plan will be updated for each phase of the work.

Appendix 4: LIST OF CONTACTS

B.C. HYDRO

ENVIRONMENTAL RESOURCES

Environmental Coordination

*	C. Lamont	- Environmental Inspector	Cellular 649-3415
*	D.R.J. Wilson	- Environmental Coord.	663-1804
	M.D. Johnston	-	663-2291
*	H.A. Smith	- Manager Fish and Water	663-4481

Waste Management Department:

A. Grikis	- Manager Waste Management	663-3351
P. Roth		663-4184
A. Deaust		663-4390
After hours		299-0311 or 293-7881

PROJECT MANAGEMENT/ENGINEERING

W.J. Brunner	- Project Manager	663-3042
C.W. Holder	- Project Engineer	663-3730
S.J. Garner	- Geotech. Engineer	663-2917

CONSTRUCTION MANAGEMENT:

*	R.M. Ellis	- Construction Manager	663-3503
*			Cellular 230-3638
*	E. Schroeder	- Construction Officer	
*			Cellular 649-3415

HYDRO FORCE CONSTRUCTION:

*	E.G. Burroughs	- Site supervisor	597-5349
*			Cellular 671-0390
*	V.E. Boley	- Site Foreman	Cellular 671-5143
*			Cellular 649-2247
	R.J. Lockhart	- Project supervisor	597-5317
*			Cellular 657-3863
	W.W. Hicks	- H.F.C Manager	597-5301

PRODUCTION DEPARTMENT:

C.J. Morrison	- Production Spvr.	462-7146
After hours	- LMC Dispatcher (24hr.)	430-8284

OPERATIONS CONTROL DEPARTMENT:

*	L. Flint-Peterson	- Operations Engineer	293-5807
	After hours	- SCC Dispatcher	293-5821/32

* Revision

CIVIL INSPECTION DEPARTMENT:

	Dick Brighton - Civil Inspt. Engineer	663-2266

EXTERNAL RELATIONS:

	T.W. Parsons - Ext. Reltns. Officer	663-4458

PROPERTIES DIVISION:

	Gary Holisko	663-4312

GOVT. OF B.C.

MINISTRY OF ENVIRONMENT - Surrey
Fish and Wildlife Branch

	Susan Latimer - Habitat Protection	584-8822
	Water Management Branch	
	Narinder Singh - Technician	584-8822
	Provincial Emergency Program	1-800-663-3456
*	Ministry of Parks - Golden Ears Park	463-3513
	Ray Peterson - District Manager	
*	Murray Carruthers - Zone Manager	

	SOLICITOR GENERAL - Alouette Corrections	463-8891
	Tom Cadieux - Director, Programs	

GOVT. OF CANADA

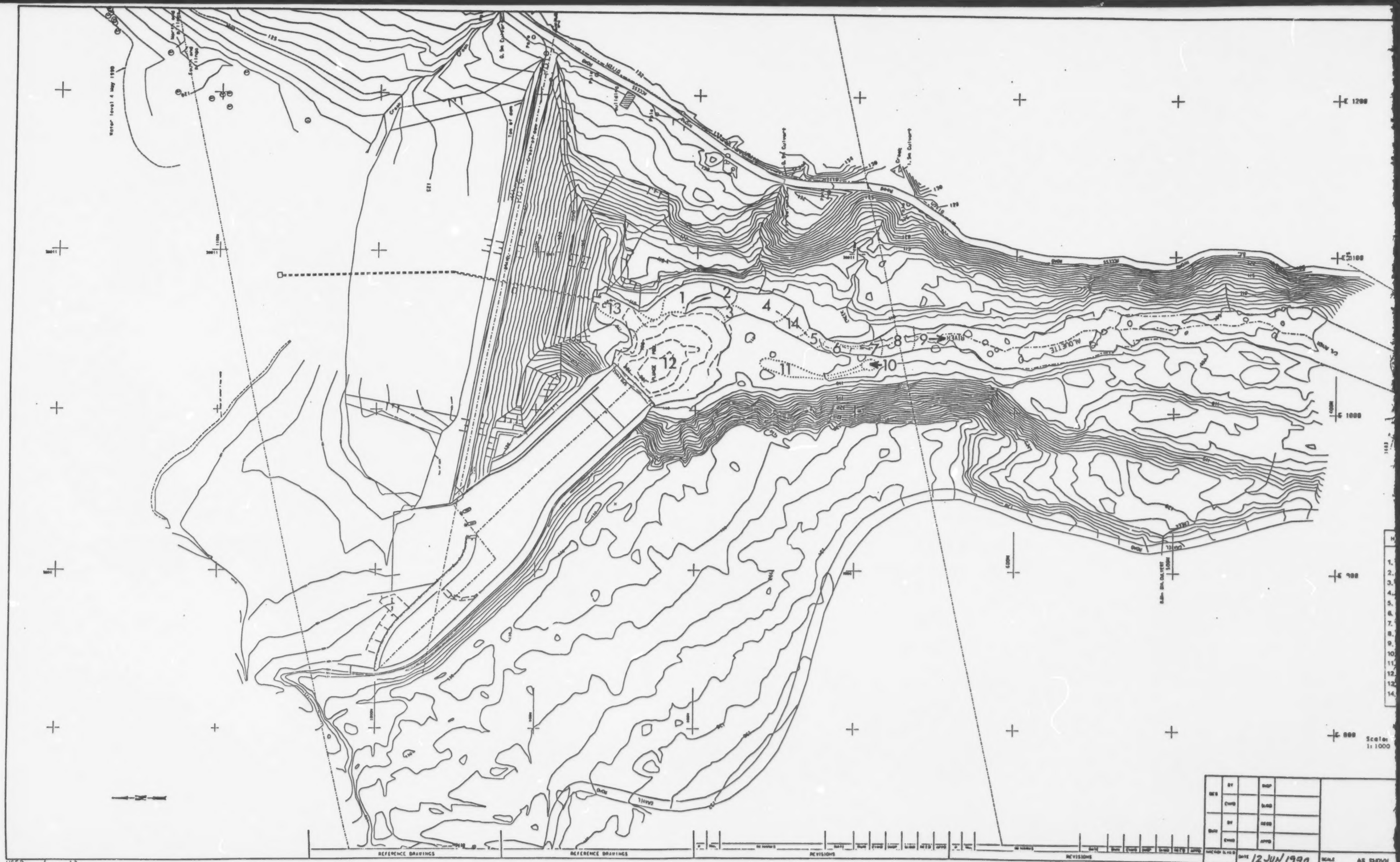
DEPARTMENT OF FISHERIES AND OCEANS

*	Water Use Unit	
*	Lee Dutta - Civil Engineer	666-3491
	ENVIRONMENT CANADA	666-6100

Appendix 5: AQUATIC HABITAT: SURVEY AND RESTORATION PLANS

CONTENTS:

Fish Habitat Map
Habitat Unit 1. Shallow Pool
Habitat Unit 2. Riffle
Habitat Unit 3. Riffle
Habitat Unit 4. Shallow Pool
Habitat Unit 5. Glide
Habitat Unit 6. Riffle
Habitat Unit 7. Pool
Habitat Unit 8. Shallow Glide
Habitat Unit 9. Riffle
Habitat Unit 10. Seepage Pool
Habitat Unit 11. Seepage Channel
Habitat Unit 12. Pool (Plunge Pool)
Habitat Unit 13. Glide (Low Level Outlet Channel)
Habitat Unit 14. Glide



REFERENCE DRAWINGS

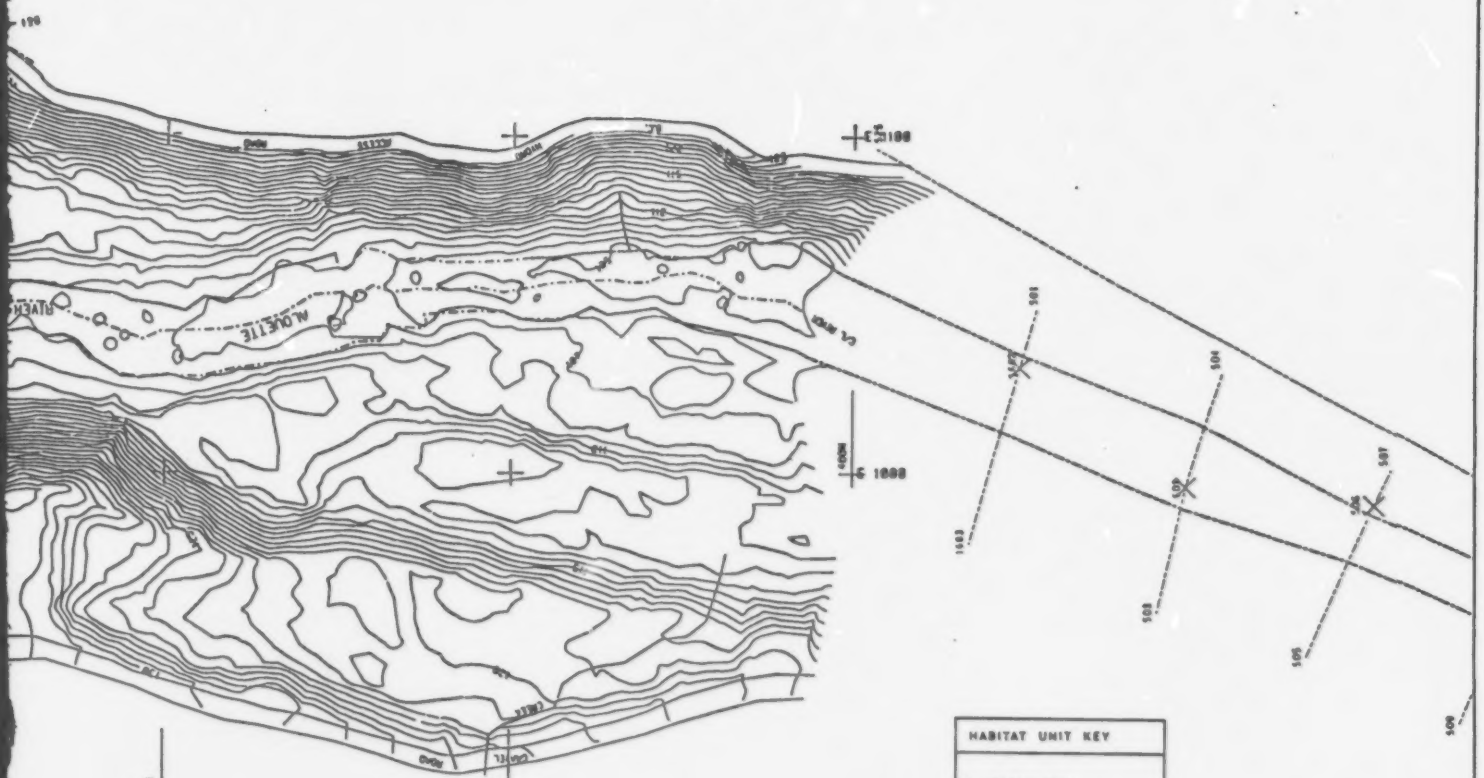
REFERENCE DRAWINGS

REVISIONS

REVISIONS

DATE 12 JUN 1990

SCALE AS SHOWN



HABITAT UNIT KEY

1. Shallow Pool
2. Riffle (gravel)
3. Riffle (gravel & boulder)
4. Shallow Pool
5. Glide
6. Riffle (boulder)
7. Pool
8. Shallow Glide
9. Riffle (boulder)
10. Seepage Pond
11. Seepage Channel
12. Plunge Pool
13. Glide (low level outlet)
14. Glide

HABITAT UNIT

Scale: 1:1000 20 0 20 40 60 80 Metres

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

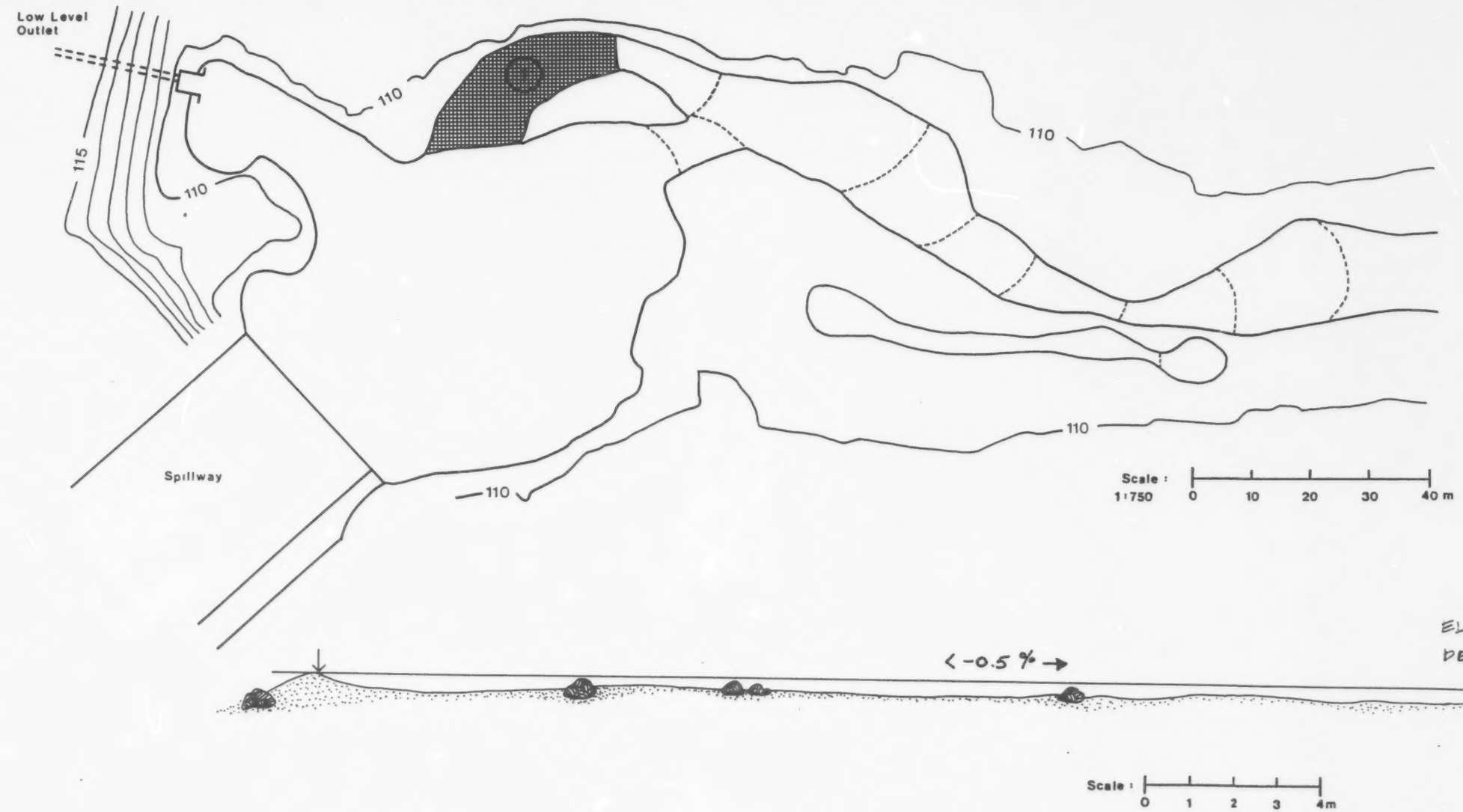
ALOUETTE DAM REHABILITATION
FISH HABITAT MAP

| REVISIONS | | |

APPENDIX 5: AQUATIC HABITAT: SURVEY AND RESTORATION PLAN

Habitat Unit 1. Shallow Pool

Area:	352 m^2	
Depth:	mean 0.3 m	maximum 0.4 m
Slope:	<0.5%	
Substrate:	90% mud	10% boulder
Cover:	50% riparian veg.	5% boulder
Velocity:	Slow	
Comments:	Coho rearing and some adult holding. Spawners observed near tailout.	



RESTORATION REQUIREMENTS

-Reconstruct channel to original specifications.
-Replace Riparian Vegetation on left bank as per Appendix 8

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HABITAT UNIT 1

POOL

DATE June 1990

DWN

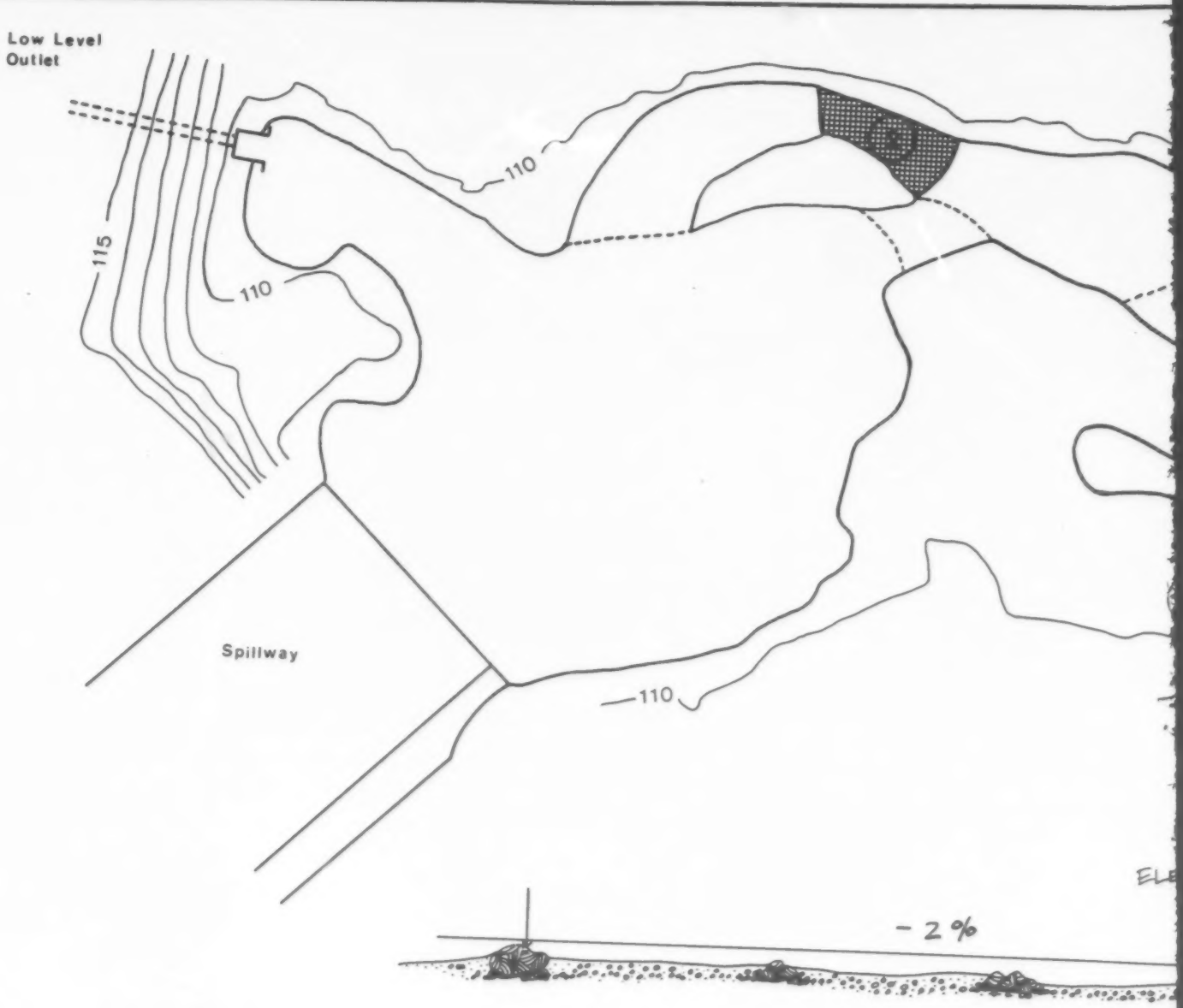
DWG. No FIG 5-2

REPORT No

APPENDIX 5: AQUATIC HABITAT: SURVEY AND RESTORATION PLAN

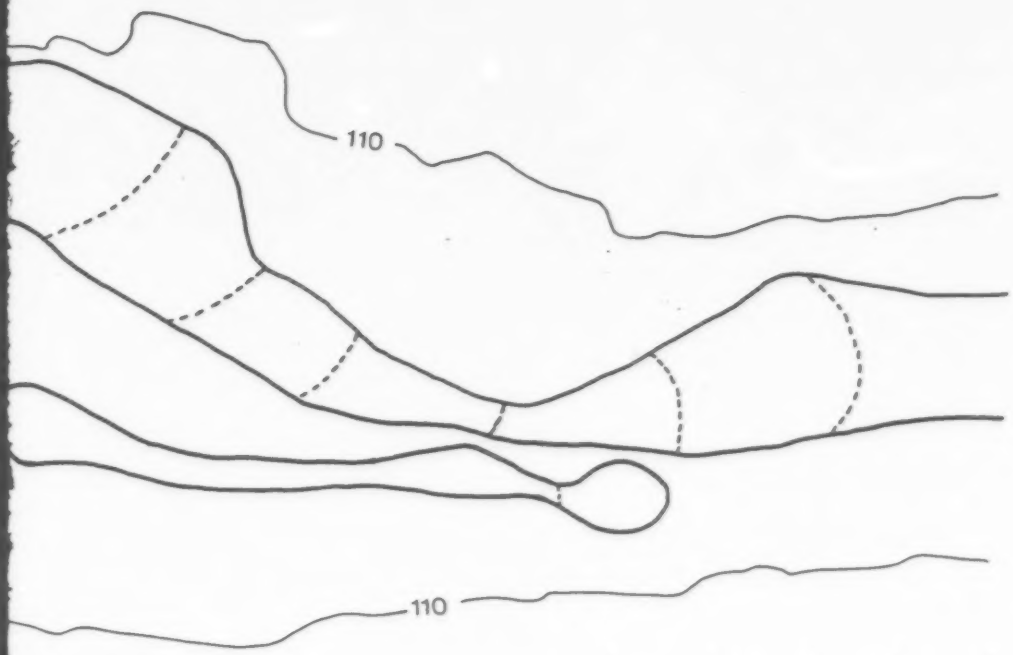
Habitat Unit 2. Riffle

Area:	118 m^2		
Depth:	mean 0.2 m	maximum 0.3 m	
Slope:	2%		
Substrate:	70% gravel	20% boulder	10% fine
Cover:	20% riparian veg.	10% boulder	
Velocity:	0.5 m/s		
Comments:	Most of the coho spawned in this area.		



RESTORATION REQUIREMENTS

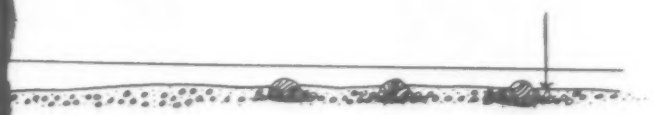
-Reconstruct to original specifications.
-Add 12m^3 of clean washed River Gravel spread to average depth of 0.2m.
-Replace Riparian Vegetation on left bar Appendix 8



Scale : 1:750

0 10 20 30 40 m

ELEVATION TO BE DETERMINED



Scale :

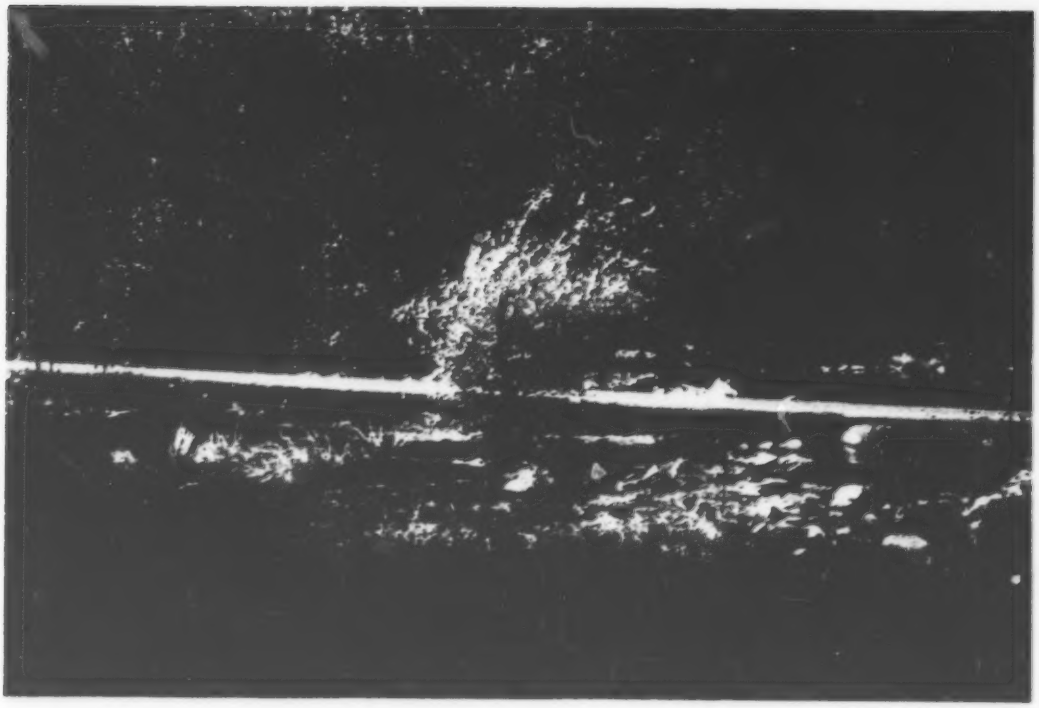
0 1 2 3 4m

cations.
Gravel (25mm-75mm)

left bank as per

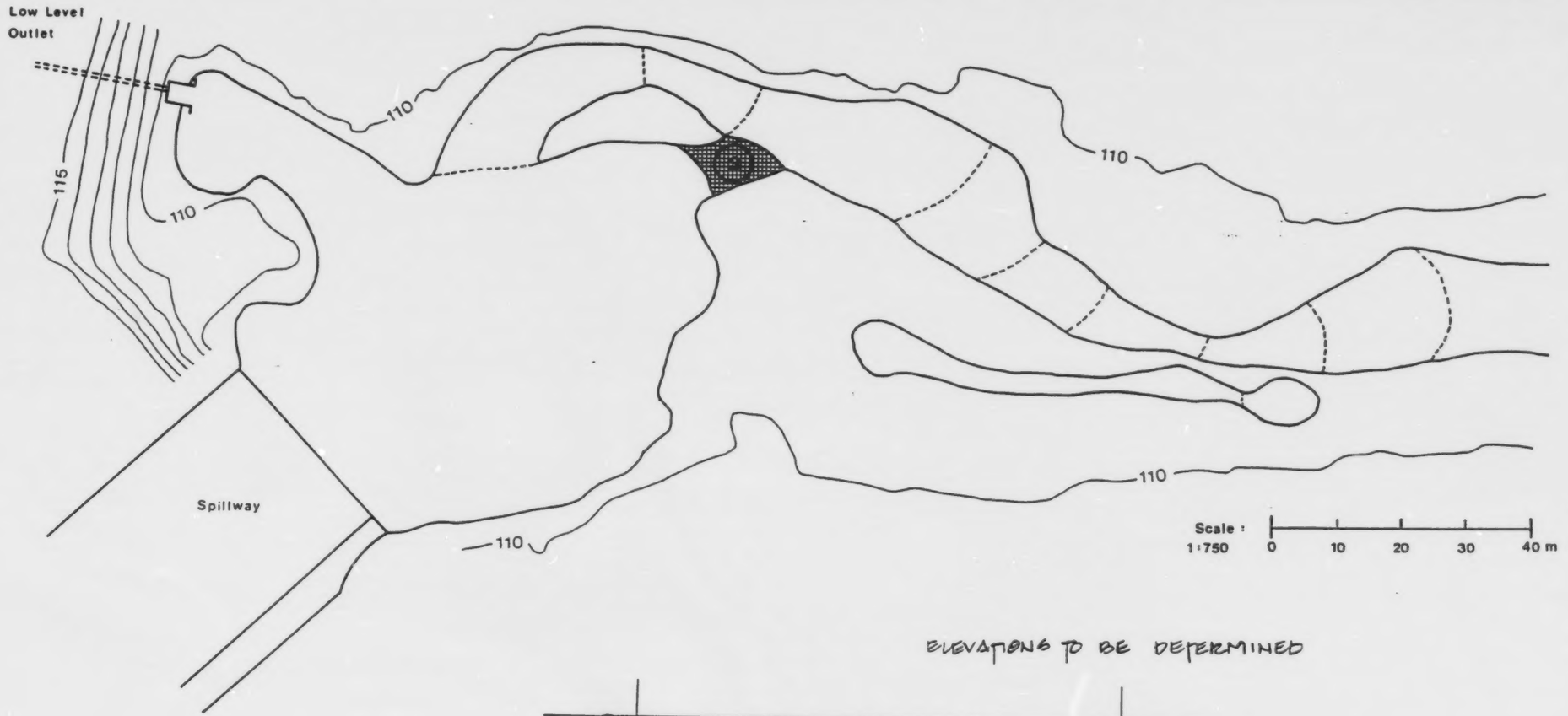
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY	
HABITAT UNIT 2 RIFFLE	
DATE June 1990	
DWN	DWG. No FIG 5-3

REPORT No



Habitat Unit 3. Riffle

Area:	75 m²		
Depth:	mean 0.2 m	maximum 0.3 m	
Slope:	2%		
Substrate:	40% boulder	50% gravel	10% fines
Cover:	20% riparian veg.	15% boulder	
Velocity:	0.6 m/s		
Comments:	Appears to be used by fish for transit only.		



ELEVATIONS TO BE DETERMINED

RESTORATION REQUIREMENTS

-Reconstruct to original specifications.
-Add 7m³ of clean washed River Gravel (25mm-75mm) spread to average depth of 0.2m.

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HABITAT UNIT 3

RIFFLE

DATE June 1990

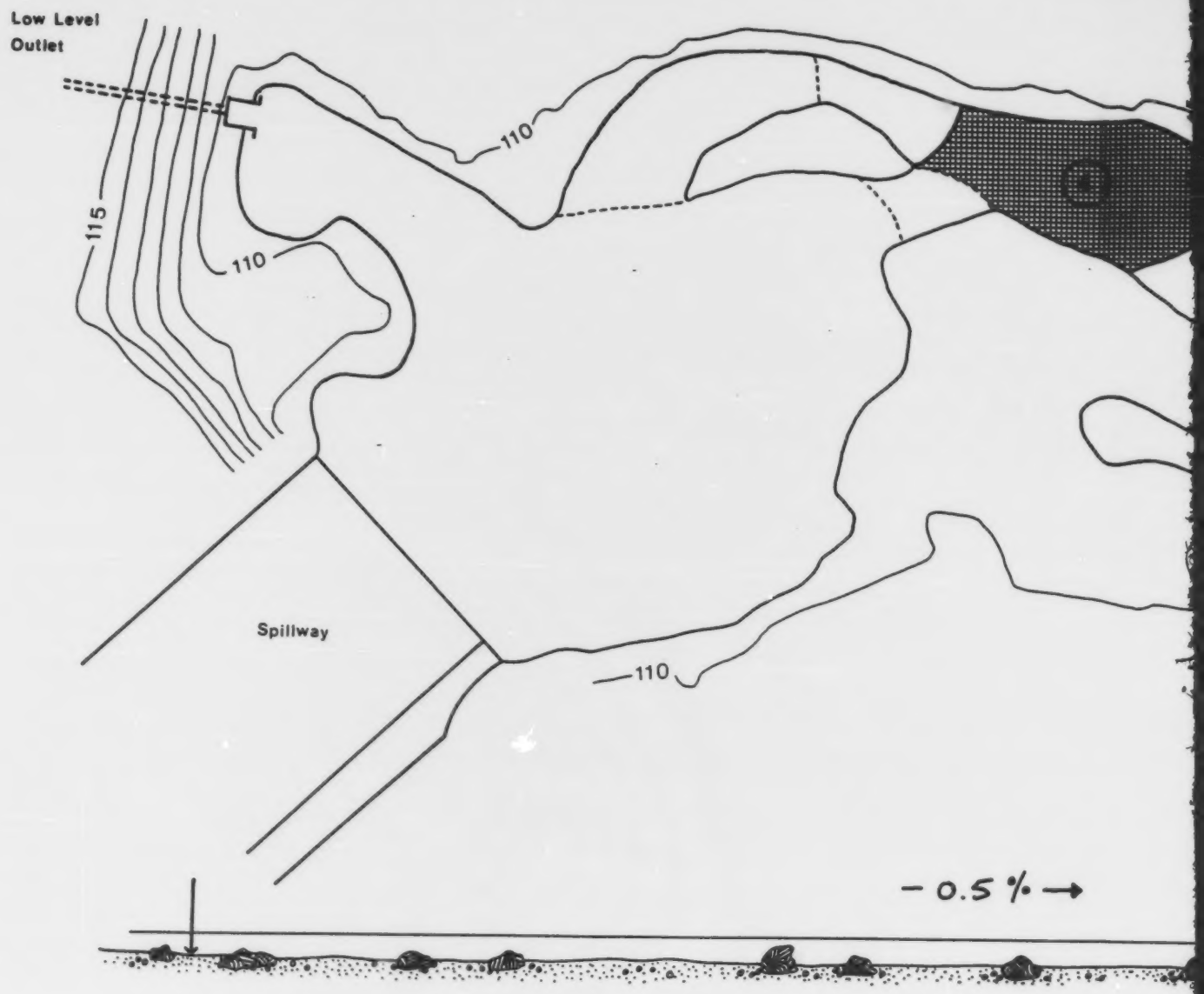
DWN

DWG. No FIG 5-4

REPORT No.

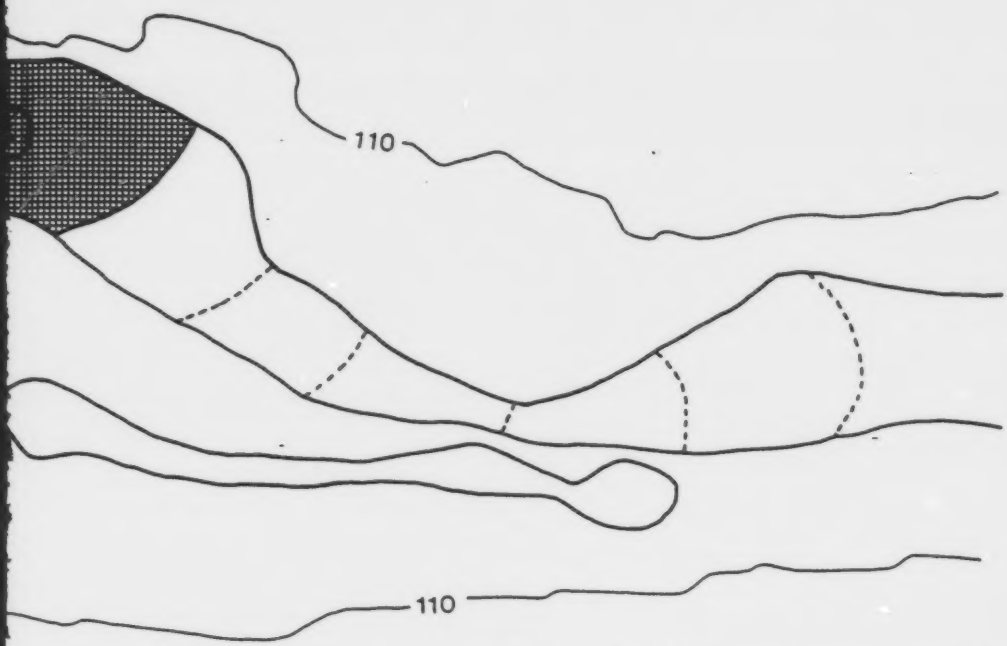
Habitat Unit 4. Shallow Pool

Area:	484 m^2		
Depth:	mean 0.4 m	maximum 1.4 m	
Slope:	0.5%		
Substrate:	70% fines	20% boulder	10% gravel
Cover:	10% riparian veg.	10% boulder	
Velocity:	slow		
Comments:	Coho adults held in this area and juveniles rear in the margins. There are deposits of good gravel along the west side which may have been used by spawning coho.		

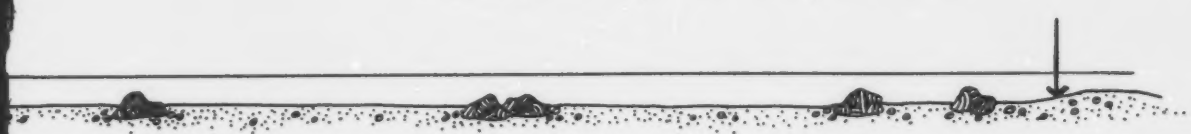


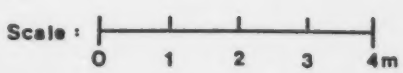
RESTORATION REQUIREMENTS

-Reconstruct to original specifations.
-Replace Riparian Vegetation on left bank as per Appendix 8.



ELEVATIONS TO BE DETERMINED





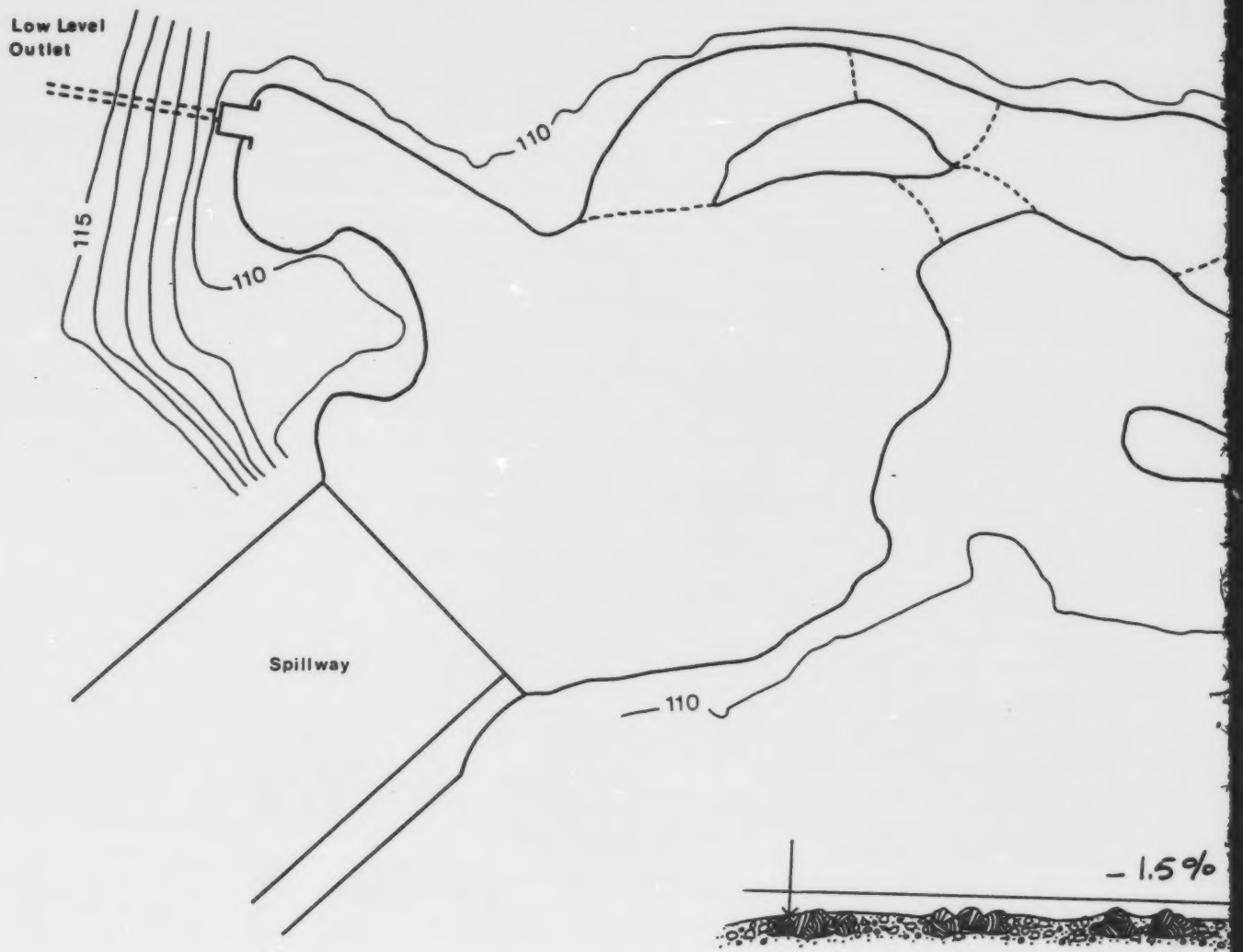
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HABITAT UNIT 4

SHALLOW POOL

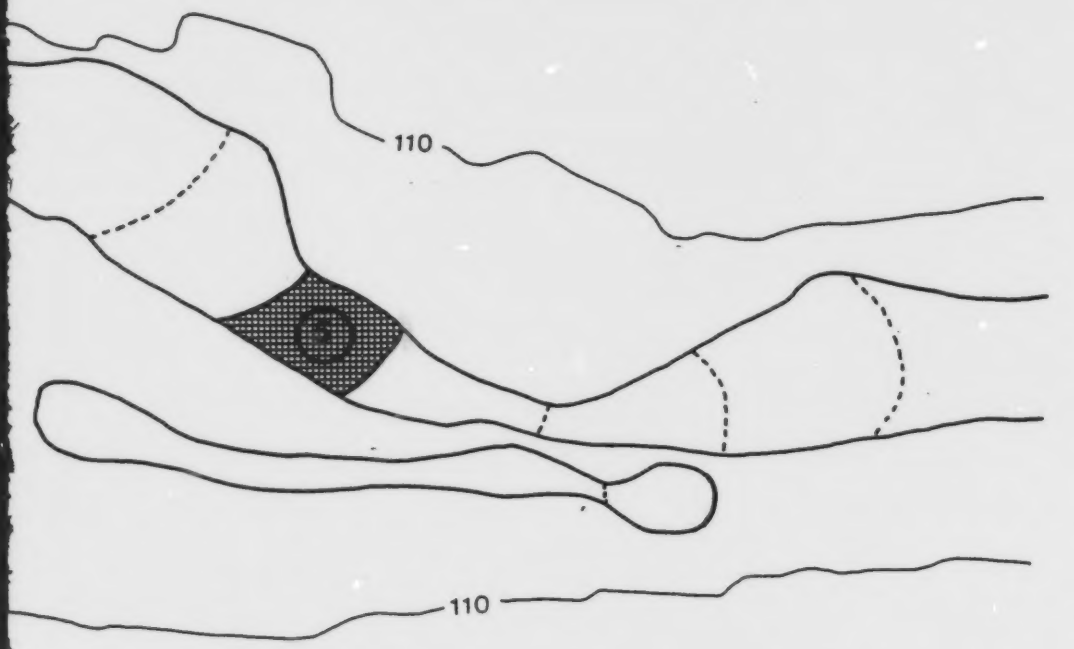
DATE June 1990	
DWN	DWG. No FIG 5-5

REPORT No



RESTORATION REQUIREMENTS

-Reconstruct to original spe



Scale : 1:750

0 10 20 30 40 m

Scale :

0 1 2 3 4m

ENTS

inal specifations.

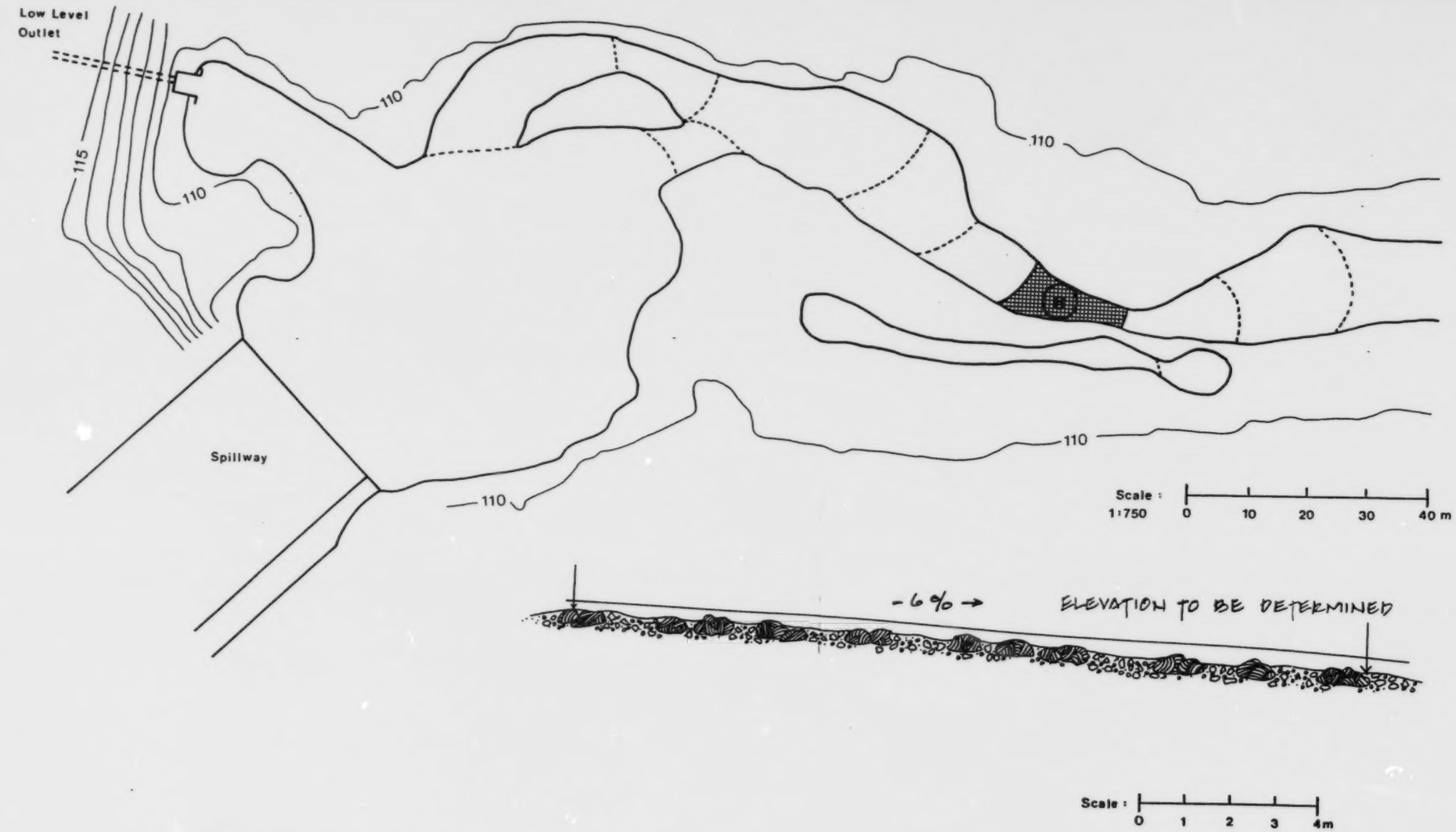
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY	
HABITAT UNIT 5 GLIDE	
DATE June 1990	
DWN	DWG. No. FIG 5-6

REPORT No

APPENDIX 5: AQUATIC HABITAT: SURVEY AND RESTORATION PLAN

Habitat Unit 5. Glide

Area:	132 m^2
Depth:	mean 0.3 m maximum 0.4 m
Slope:	1.5%
Substrate:	50% boulder 20% cobble 10% gravel 20% sand
Cover:	30% riparian veg. 10% boulder
Velocity:	0.75 m/s
Comments:	Start of this glide is 130 m from LLO. There is 2 m^2 of good spawning gravel near the head of this unit.



RESTORATION REQUIREMENTS

-Reconstruct to original specifations
-Replace Riparian Vegetation on right bank as per Appendix 8

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HABITAT UNIT 6

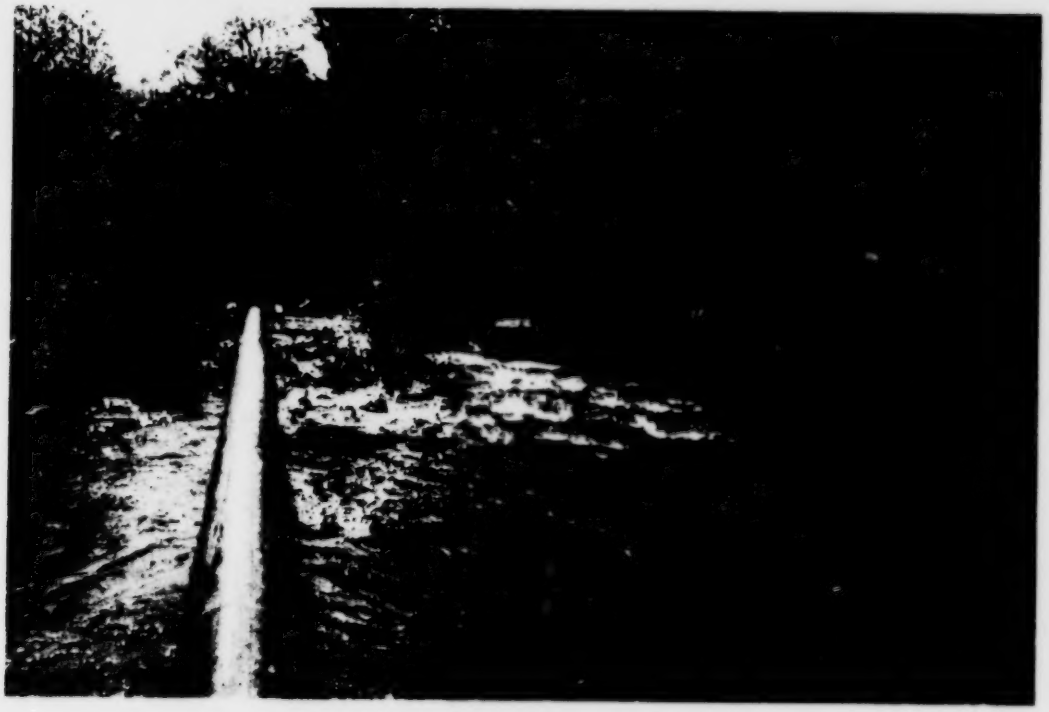
BOULDER RIFFLE

DATE June 1990

DWN

DWG. No. FIG 5-7

REPORT No



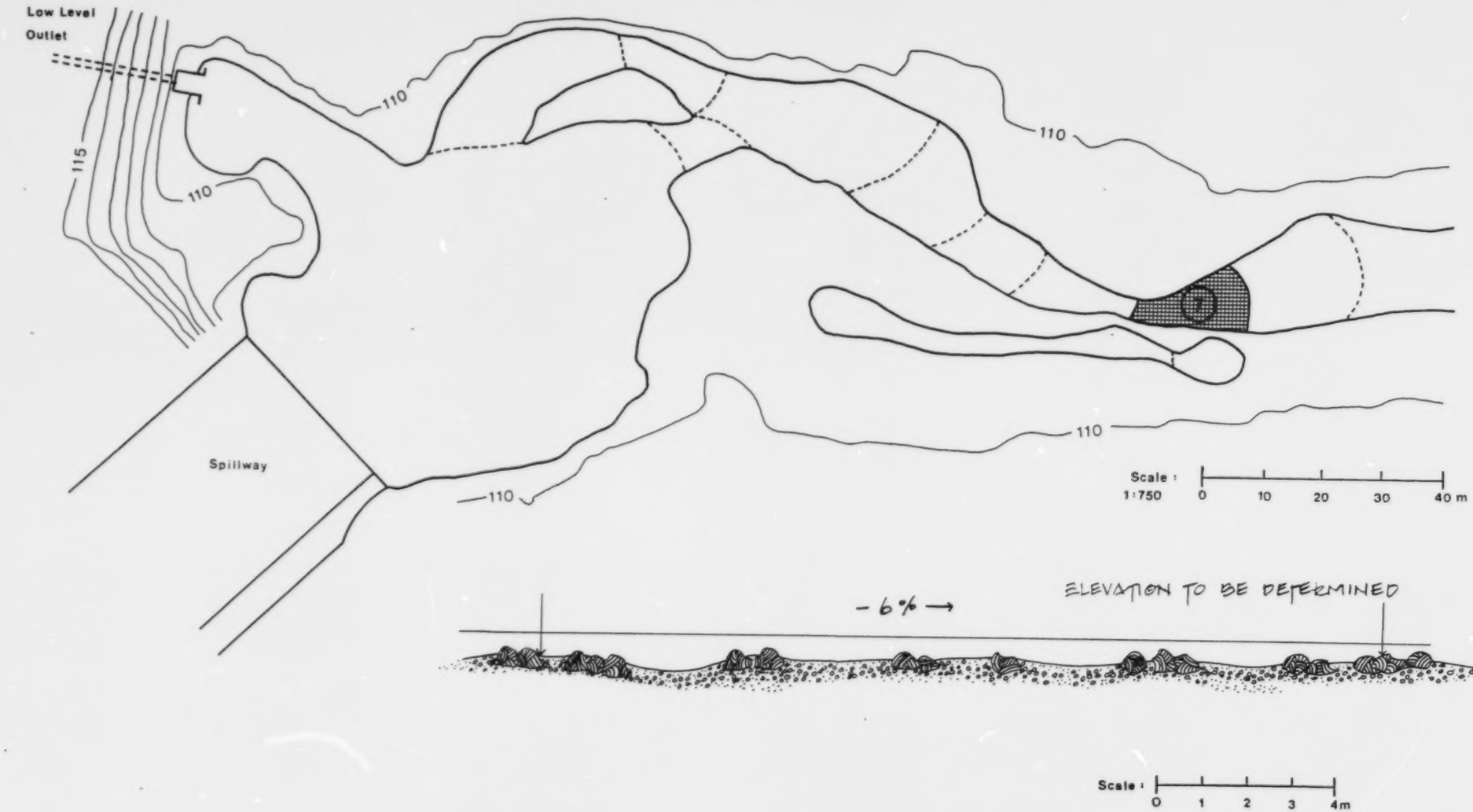
Habitat Unit 6. Riffle

Area:	106 m^2		
Depth:	mean 0.2 m	maximum 0.3 m	
Slope:	6%		
Substrate:	70% boulder	20% cobble	10% gravel
Cover:	40% riparian veg.	30% white water	15% boulder
Velocity:			
Comments:	This unit is 32 m long and ends 10 m above the end of the pipeline. Appears to offer some steelhead rearing.		

APPENDIX 5: AQUATIC HABITAT: SURVEY AND RESTORATION PLAN

Habitat Unit 7. Pool

Area:	137 m^2		
Depth:	mean 0.4 m	maximum 0.9 m	
Slope:	1%		
Substrate:	50% gravel	30% boulder	20% fine
Cover:	10% riparian veg.	10% boulder	
Velocity:			
Comments:	Gravel is located along the west bank, boulders in central thalweig.		



RESTORATION REQUIREMENTS

-Reconstruct to original specifations.

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HABITAT UNIT 7

BOULDER RIFFLE

DATE June 1990

DWN

DWG No FIG 5-8

REPORT No

APPENDIX 5: AQUATIC HABITAT: SURVEY AND RESTORATION PLAN

Habitat Unit 8. Shallow Glide

Area:	304 m^2	
Depth:	mean 0.3 m	maximum 0.6 m
Slope:	<1%	
Substrate:	60% sand	40% boulder
Cover:	5% riparian veg.	5% boulder
Velocity:		
Comments:	Adult coho held in this area, juveniles rear in the margins.	

Habitat Unit 8

Pre Project Enhancement:

Place 50m^3 clean washed river gravel (25mm - 75mm). Gravel is to be spread evenly to a minimum depth of 0.2m.

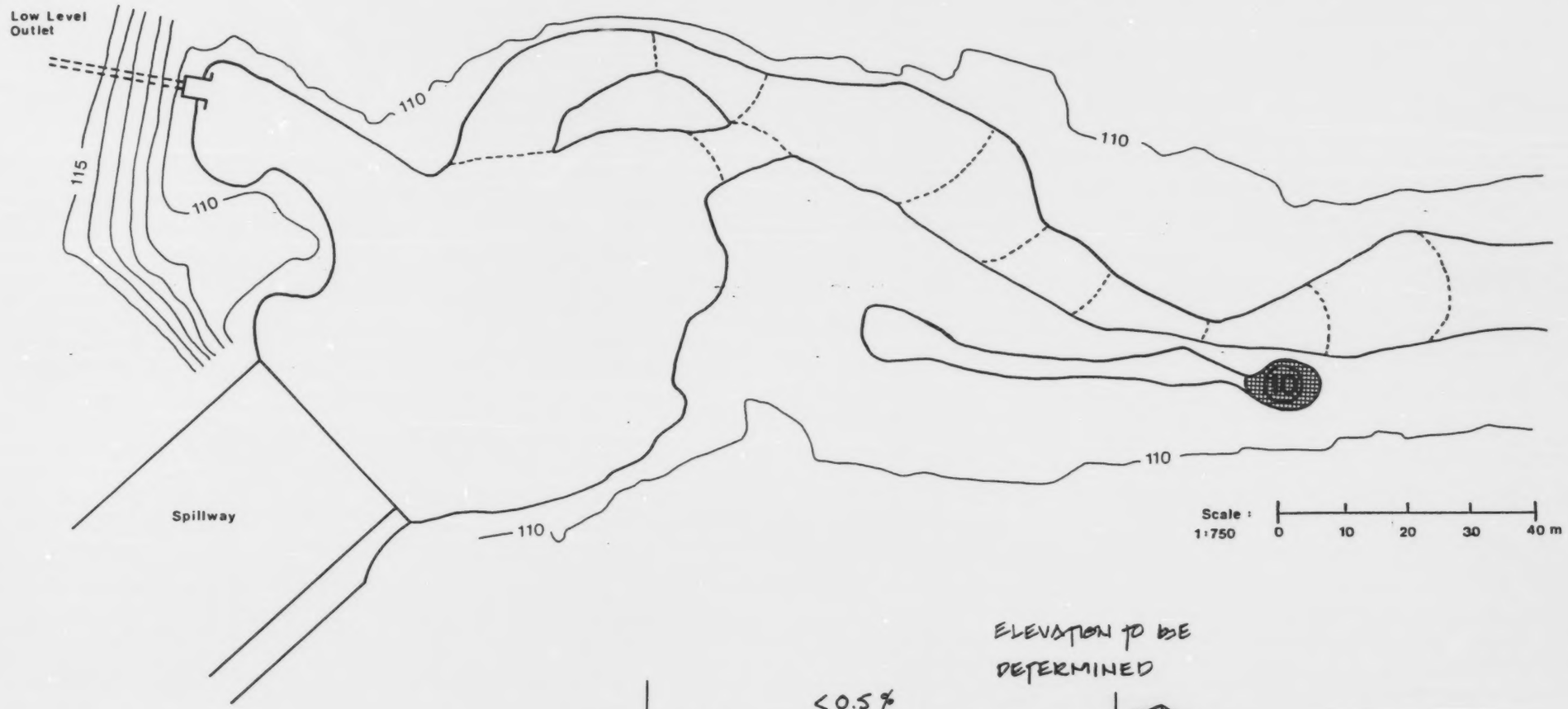
Work is to be undertaken after 15 July and complete before 15 September.

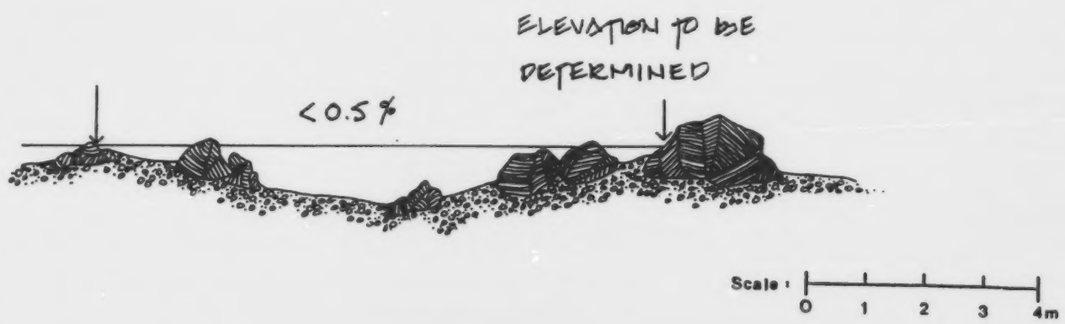
Habitat Unit 9. Riffle

Area:	not surveyed		
Depth:	mean 0.2 m	maximum 0.3 m	
Slope:			
Substrate:	80% boulder	15% gravel	5% sand
Cover:	15% boulder	10% white water	5% rip. veg.
Velocity:			
Comments:	Appears to be good steelhead rearing.		

Habitat Unit 10. Seepage Pool

Area:	74 m^2		
Depth:	mean 0.4 m	maximum 1.0 m	
Slope:	<0.5%		
Substrate:	60% gravel	30% boulder	10% sand
Cover:	60% riparian veg	10% boulder	
Velocity:	trace.		
Comments:	Appears to provide excellent rearing. This pond had a litter/detritus substrate until the spill last fall.		





RESTORATION REQUIREMENTS

-Reconstruct to original specifations.
-Replace Riparian Vegetation as per
Appendix 8

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HABITAT UNIT 10

SEEPAGE POOL

DATE June 1990

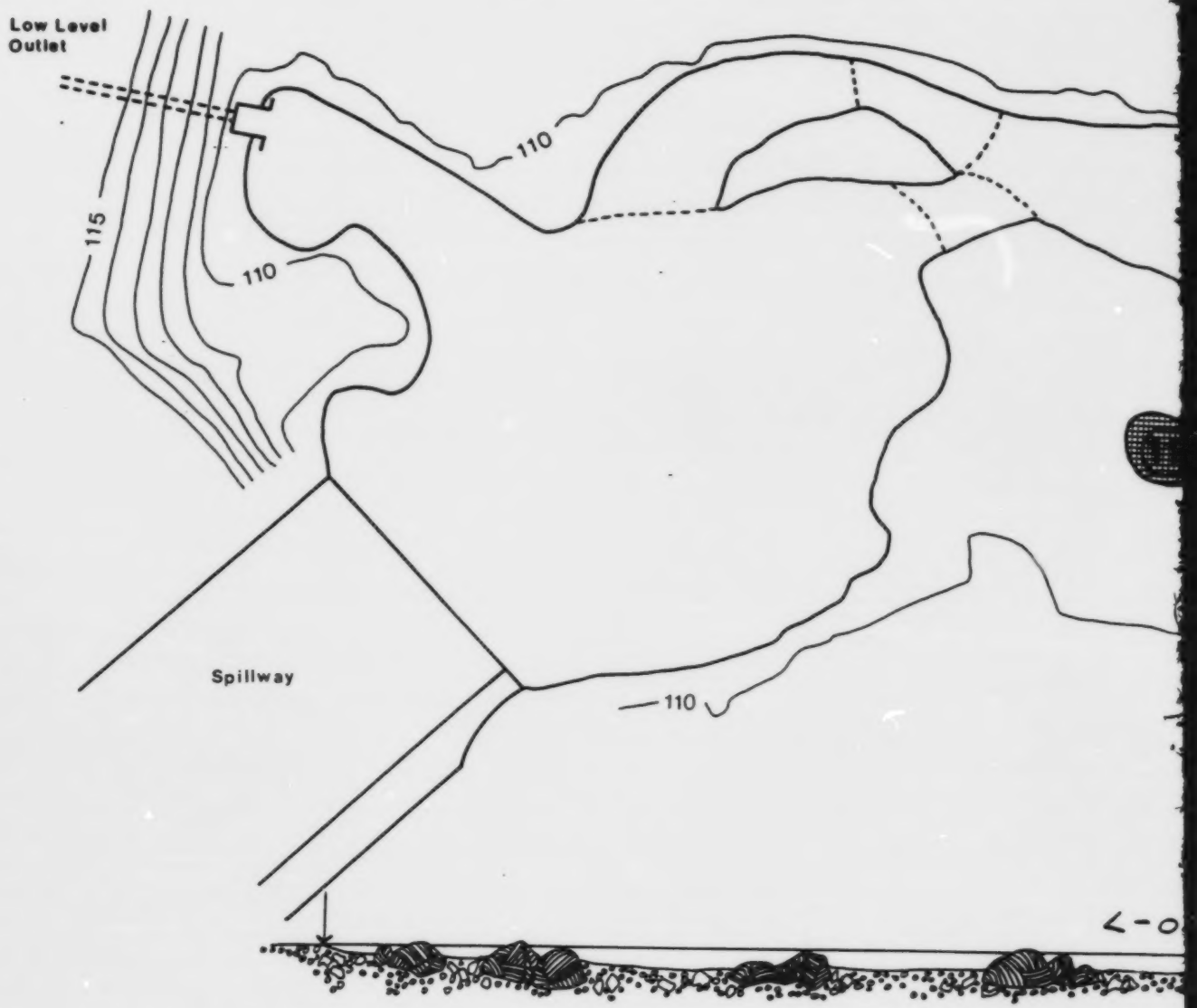
DWN

DWG. No **FIG 5-9**

REPORT No

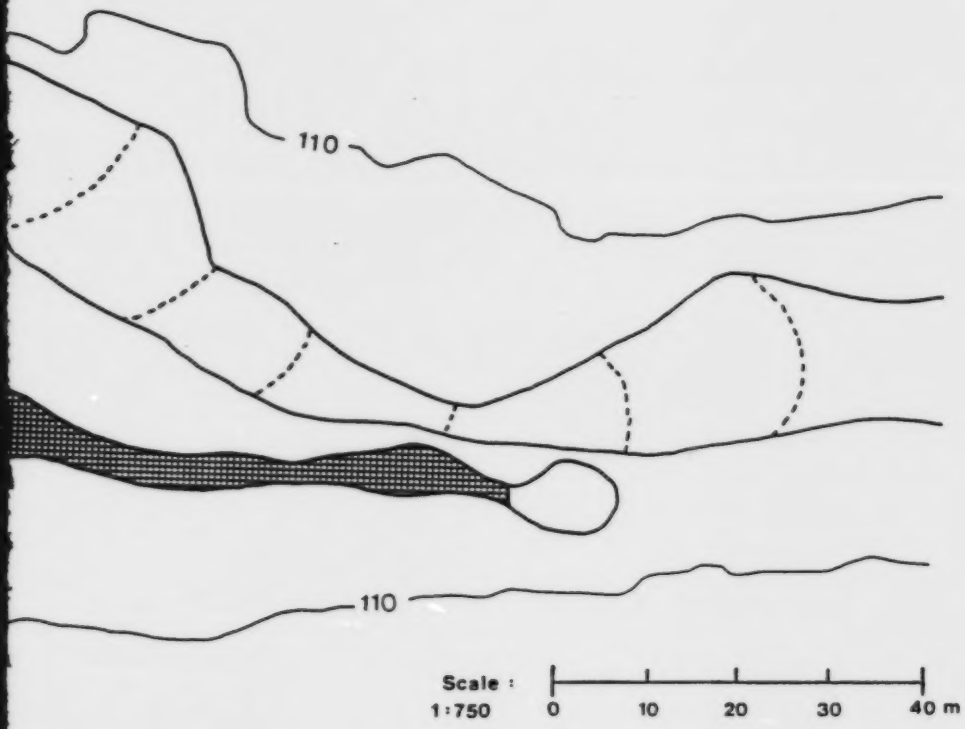
Habitat Unit 11. Seepage Channel

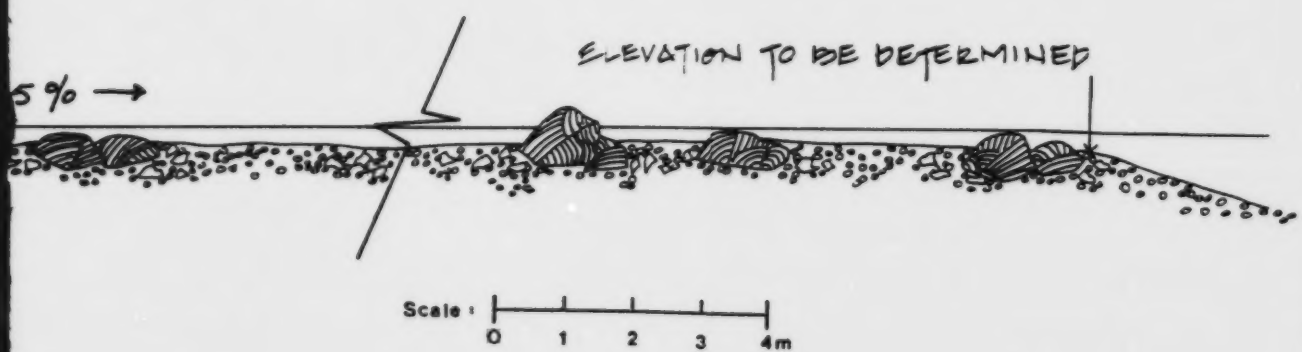
Area:	250 m^2		
Depth:	mean 02 m	maximum 0.3 m	
Slope:			
Substrate:	60% gravel	30% boulder	10% cobble
Cover:	100% riparian veg	10 % boulder	
Velocity:	trace		
Comments:	Rearing fish observed in this area. Algal/detrital mats on substrate removed by spills.		



RESTORATION REQUIREMENTS

-Reconstruct to original specifications.
-Replace Riparian Vegetation as per Appendix 8





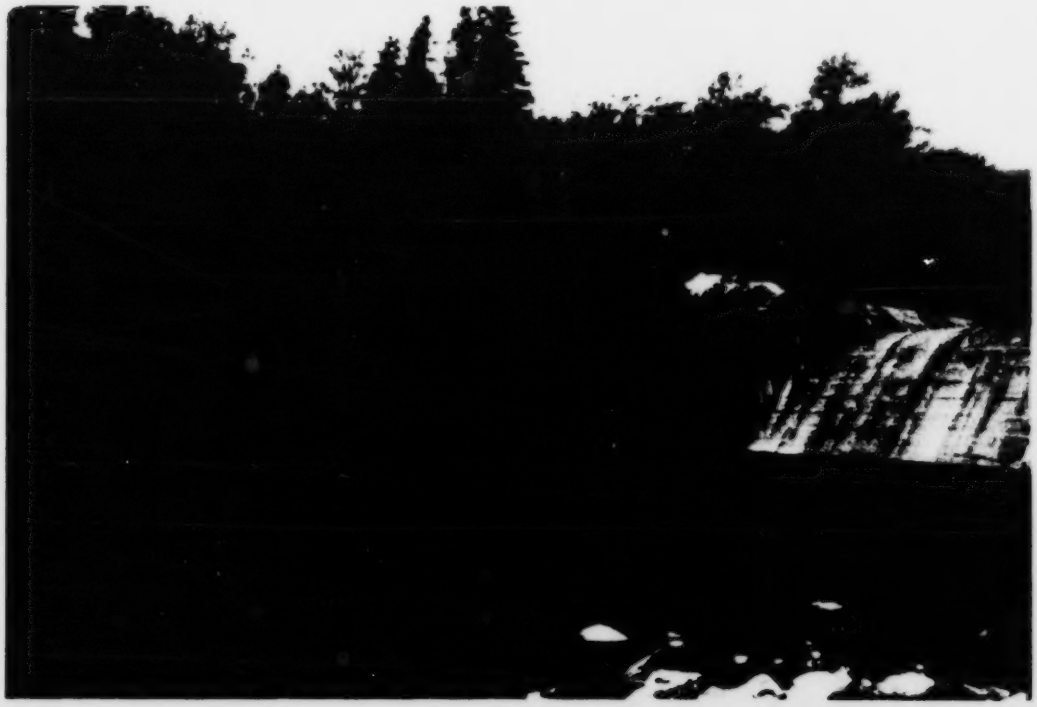
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HABITAT UNIT 11

SEEPAGE CHANNEL

DATE June 1990	
DWN	DWG No FIG 5-10

REPORT No



Habitat Unit 12. Pool (Plunge Pool)

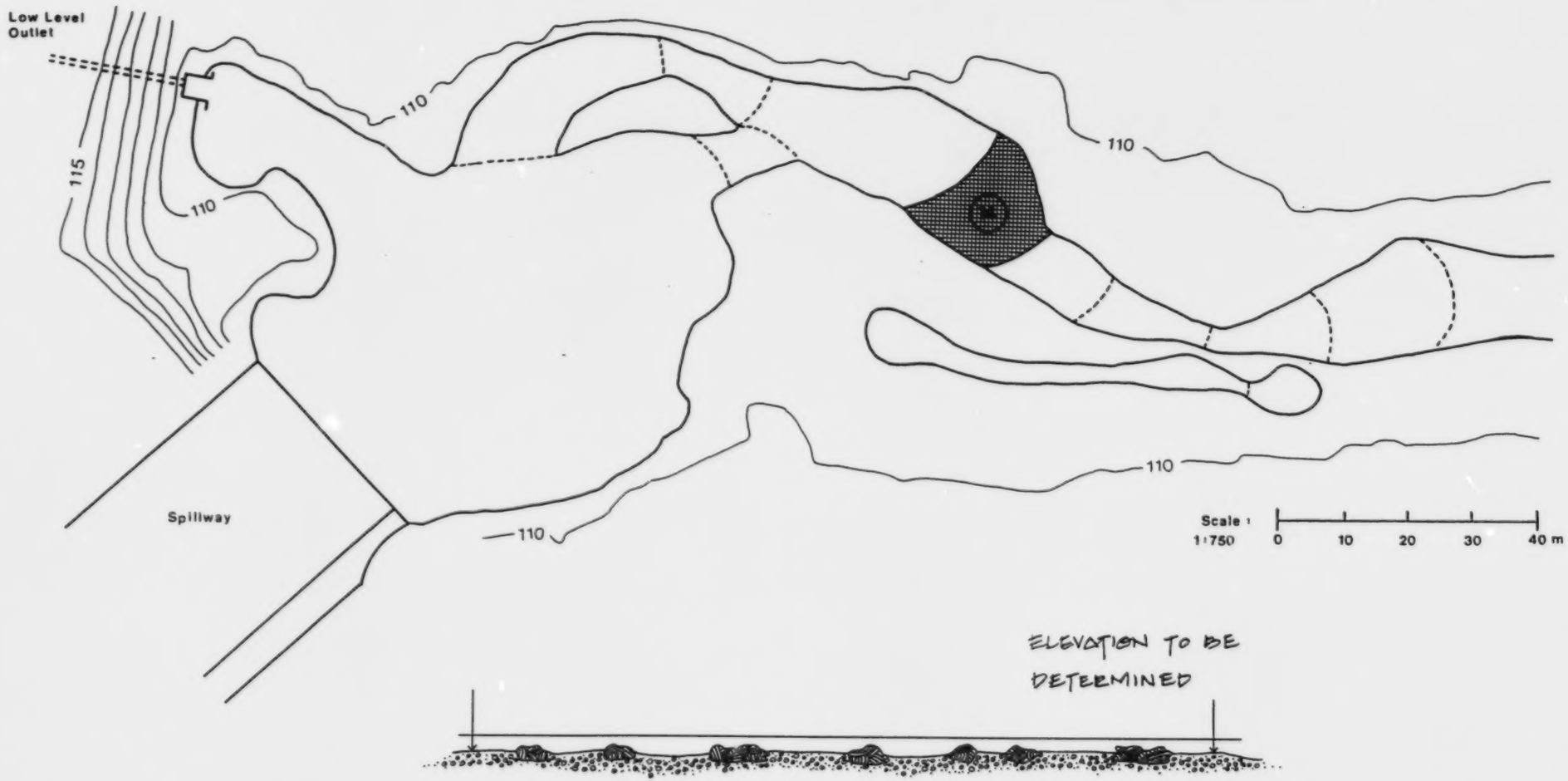
Area:	3,076 m^2		
Depth:	mean 1.0 m	maximum 5.7 m	
Slope:			
Substrate:	40% boulder	40% fine	20% gravel
Cover:	15% boulder		
Velocity:	trace		
Comments:	Pool is used extensively by rearing juvenile fish and holding adults.		

Habitat Unit 13. Glide (Low Level Outlet channel)

Area:	456 m^2		
Depth:	mean 0.5 m	maximum 1.4 m	
Slope:			
Substrate:	60% fine	30% boulder	10% gravel
Cover:	5% boulder		
Velocity:			
Comments:	Few fish observed in this area.		

Habitat Unit 14. Glide

Area:	250 m^2		
Depth:	mean 0.3 m	maximum 0.5 m	
Slope:	0.8%		
Substrate:	50% gravel	30% boulder	20% fines
Cover:	15% riparian veg.	5% boulder	5% LOD
Velocity:			
Comments:	A few coho may spawn in this area.		



Scale : 0 1 2 3 4m

RESTORATION REQUIREMENTS

-Reconstruct to original specifications.
-Add 25m³ of clean washed River Gravel (25mm-75mm)
-Replace Riparian Vegetation on left bank and right bank as per Appendix 8

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HABITAT UNIT 14

GLIDE

DATE June 1990

DWN

DWG No FIG 5-11

REPORT No

Cofferdam

EL. 125.5 m

Low level Outlet Pipe

Sediment Laden Water Discharge Pipe

1100 metres to Deep Water Discharge Point

ROAD

GRAVEL

TOP OF DAM

SHEETPILE CUT

SECURITY

Rockfill Fill Slope

Permanent Cover Mix

Plunge Pool Sump

EXISTING LOW LEVEL OUTLET EXTENSION

Modular Containment Dyke

Wattle Fence

Left Bank Access Road

Shallow Interceptor Ditch

Temporary Snow Fence

0.5 % Grade

(Manway Typ.

Flume to Plunge Pool Excavation

Plunge Pool Excavation

Relay Pipe

Right Bank Access Road

Temporary Cover Seed Mix

FENCE

Diversion Ditch

Permanent Cover Mix

0.5% Grade

Wattle Fencing

Shallow Interceptor Ditch

Relay Overflow Tank

Catch Basin

Sand Bag Curb Berm

Clean Water Discharge

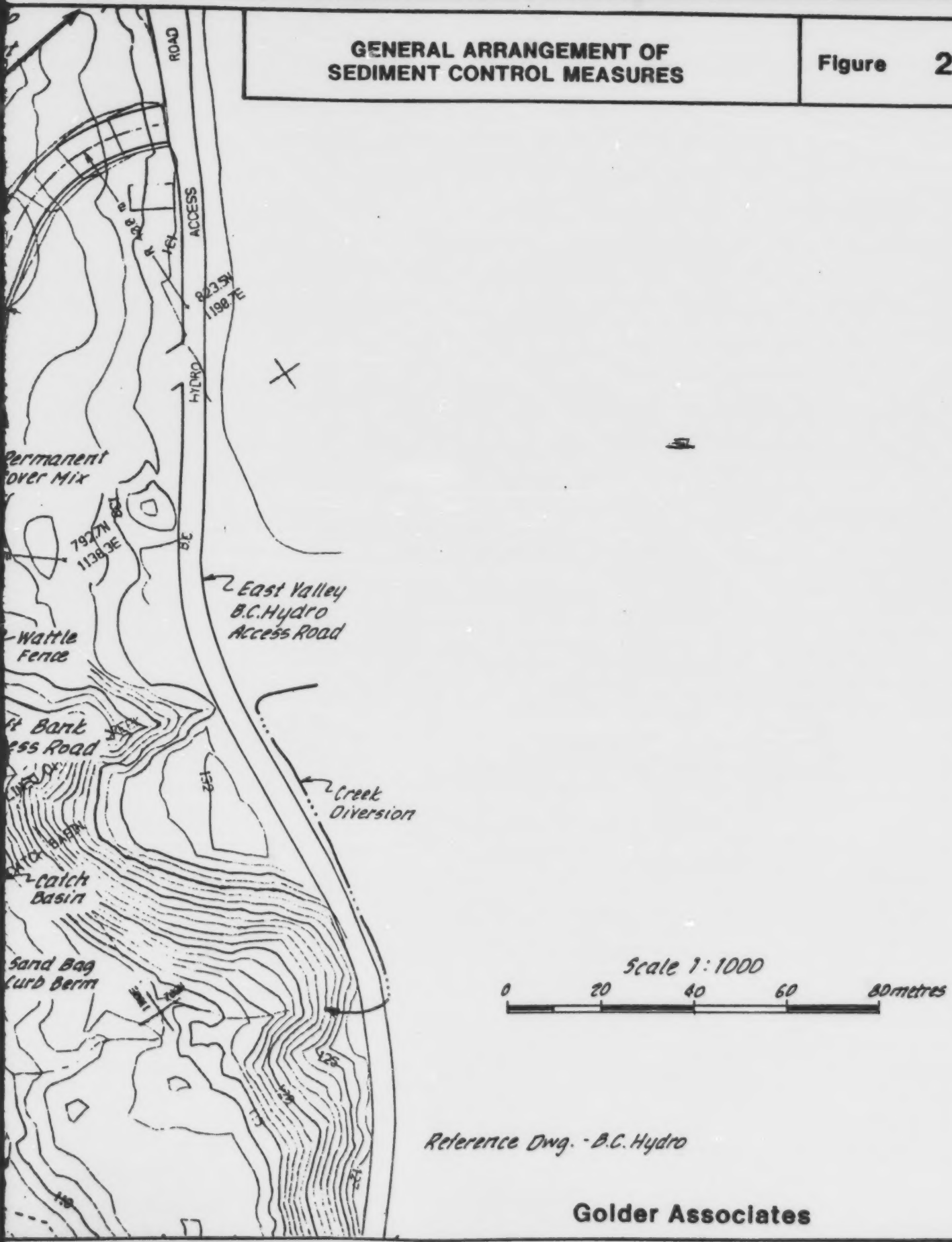
Work Area

Flow

CREEK

GENERAL ARRANGEMENT OF SEDIMENT CONTROL MEASURES

Figure 2

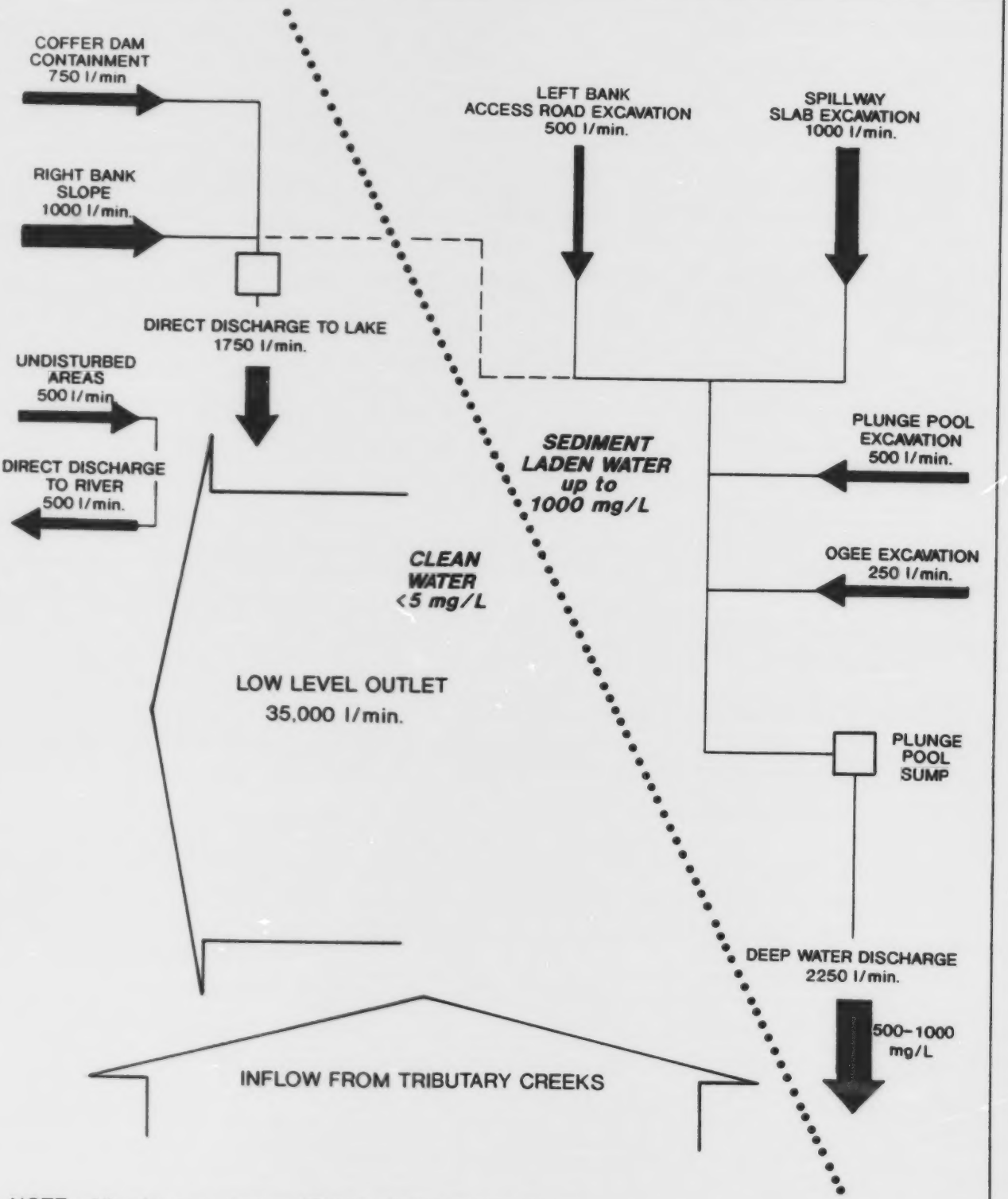


Golder Associates

902-1132

SCHEMATIC FLOW DIAGRAM OF WATER HANDLING SYSTEM

Figure 3


COFFER DAM CONTAINMENT 750 l/min
RIGHT BANK SLOPE 1000 l/min.
LEFT BANK ACCESS ROAD EXCAVATION 500 l/min.
SPILLWAY SLAB EXCAVATION 1000 l/min.
DIRECT DISCHARGE TO LAKE 1750 l/min.
UNDISTURBED AREAS 500 l/min.
DIRECT DISCHARGE TO RIVER 500 l/min.
SEDIMENT LADEN WATER up to 1000 mg/L
PLUNGE POOL EXCAVATION 500 l/min.
CLEAN WATER <5 mg/L
OGEE EXCAVATION 250 l/min.
LOW LEVEL OUTLET 35,000 l/min.
PLUNGE POOL SUMP
DEEP WATER DISCHARGE 2250 l/min.
500-1000 mg/L
INFLOW FROM TRIBUTARY CREEKS

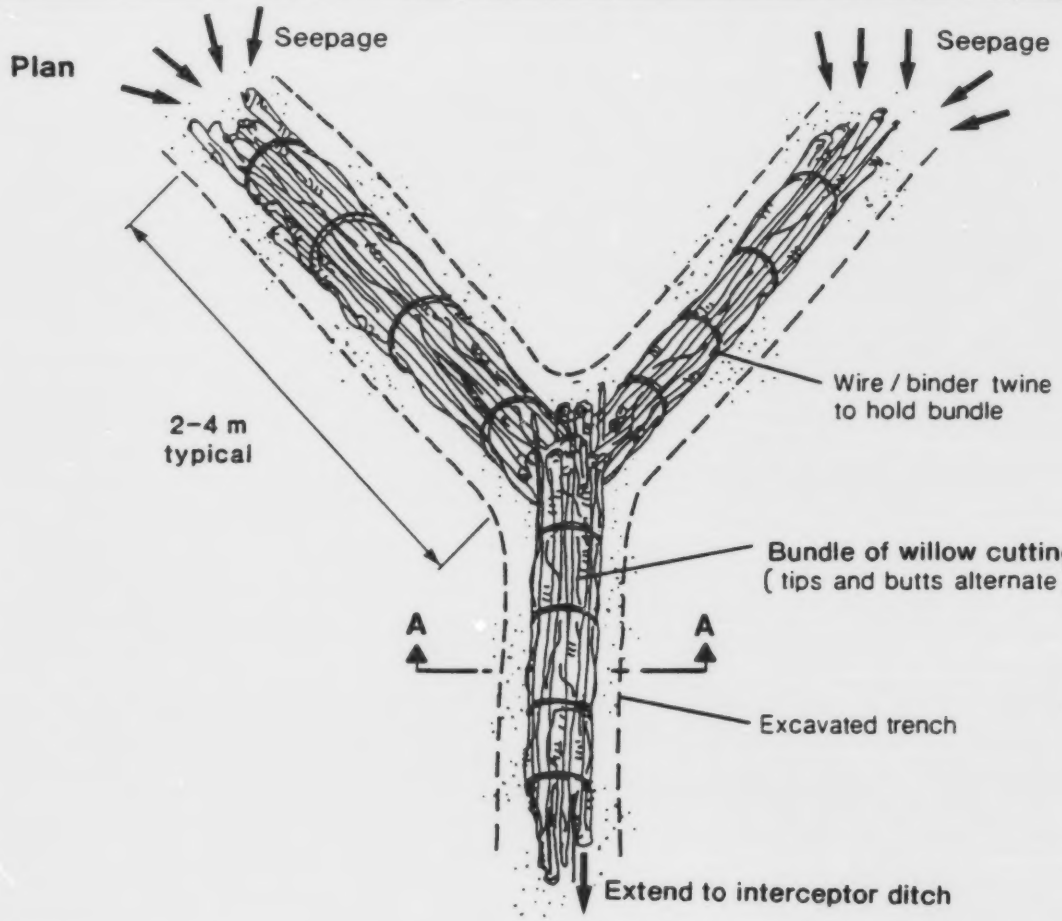
NOTE : All volumes assume 10 year design storm event.
(157mm in 24 hours).

PROJECT NO 902-1132 DRAWN REVIEWED A.R. DATE July/90

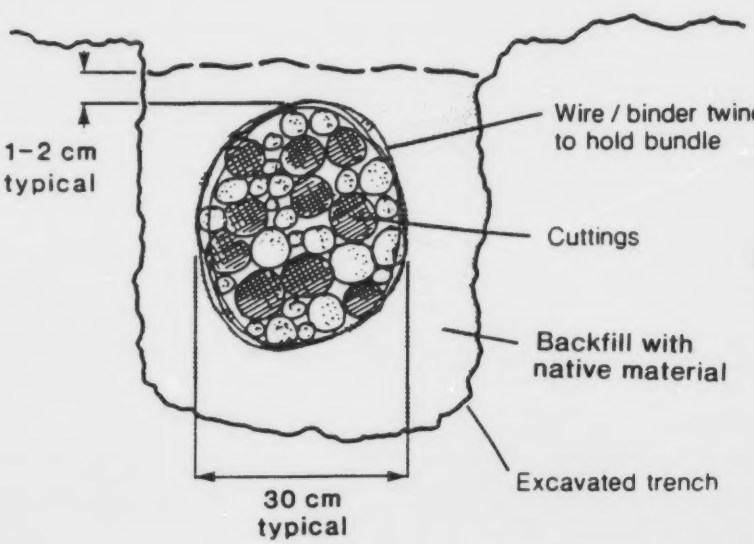
Golder Associates

DETAIL OF LIVE POLE DRAIN INSTALLATION SECTION

Figure 4



Section A – A



NOTE :

Layout of drains and dimensions to suit site conditions.
Place areas where seepage is encountered during slope excavation.

Not to Scale

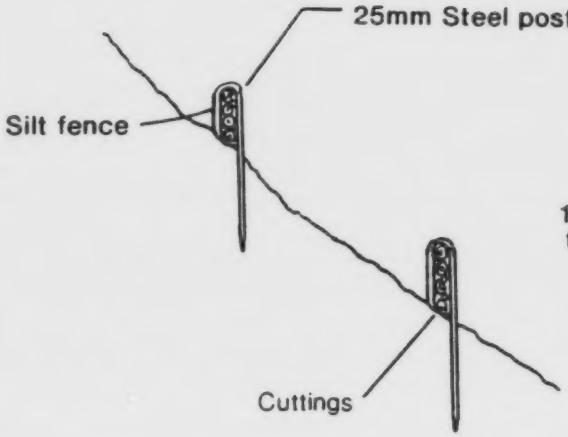
Golder Associates

PROJECT NO 902-1132 DRAWN — REVIEWED A.R. DATE July/90

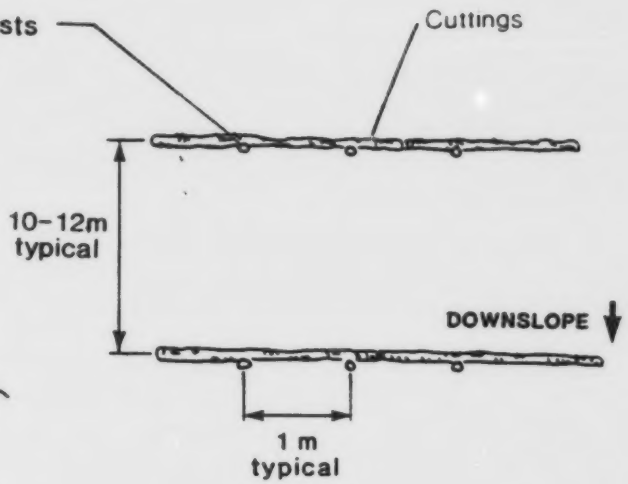
DETAIL OF WATTLE FENCING INSTALLATION

Figure 5

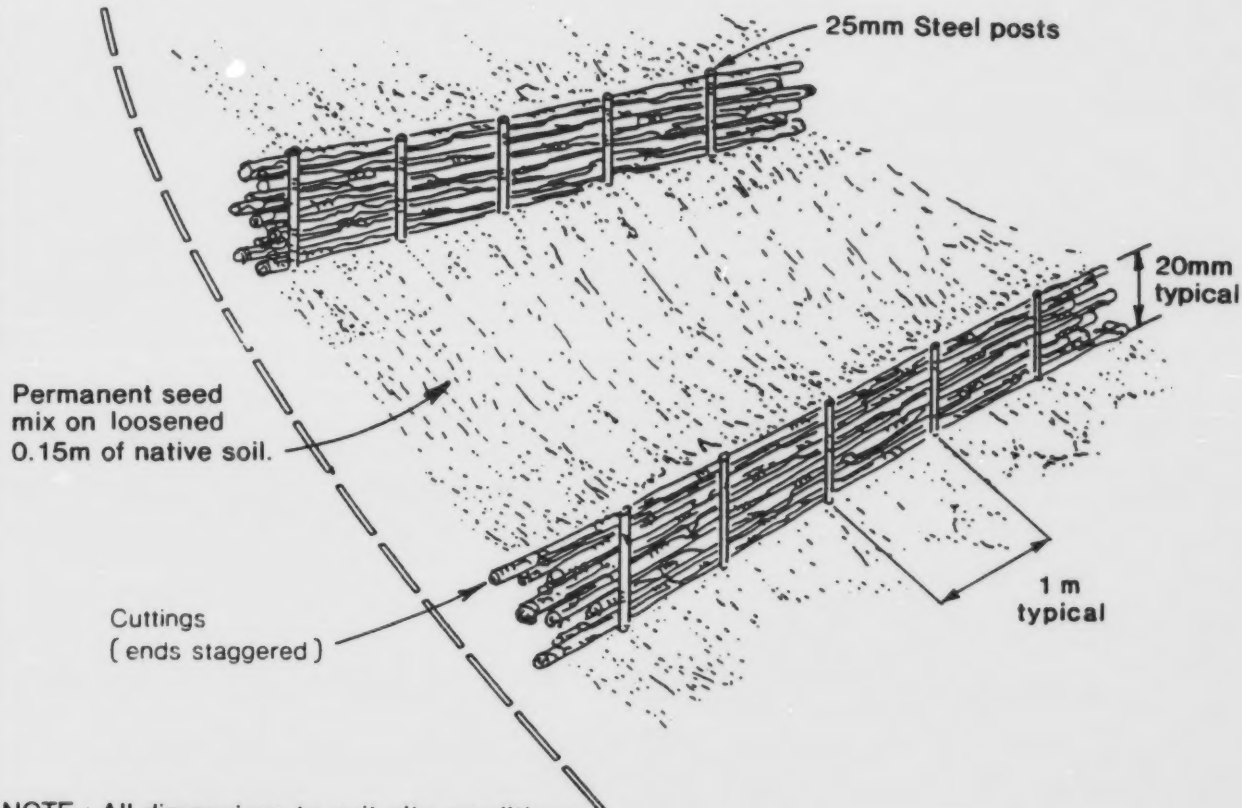
Section:



Plan:



Elevation:



NOTE : All dimensions to suit site conditions.
Steel posts to be 25mm bar.
Silt fence to consist of Exxon GTF 1015, Amoco Propex Silt Stop or equivalent.

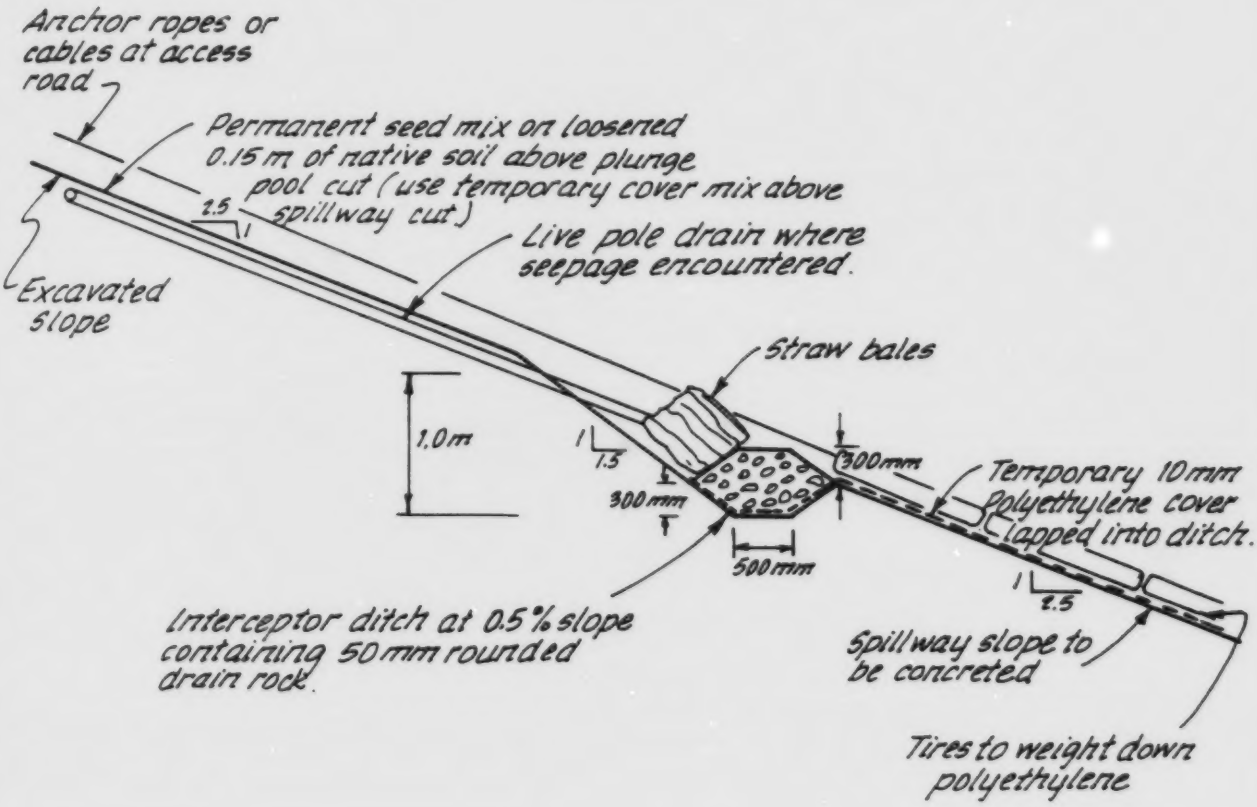
Not to Scale

Golder Associates

PROJECT NO 902-1132 DRAWN — REVIEWED A.R. DATE July/90

DETAIL OF RIGHT BANK INTERCEPTOR DITCH

Figure 6

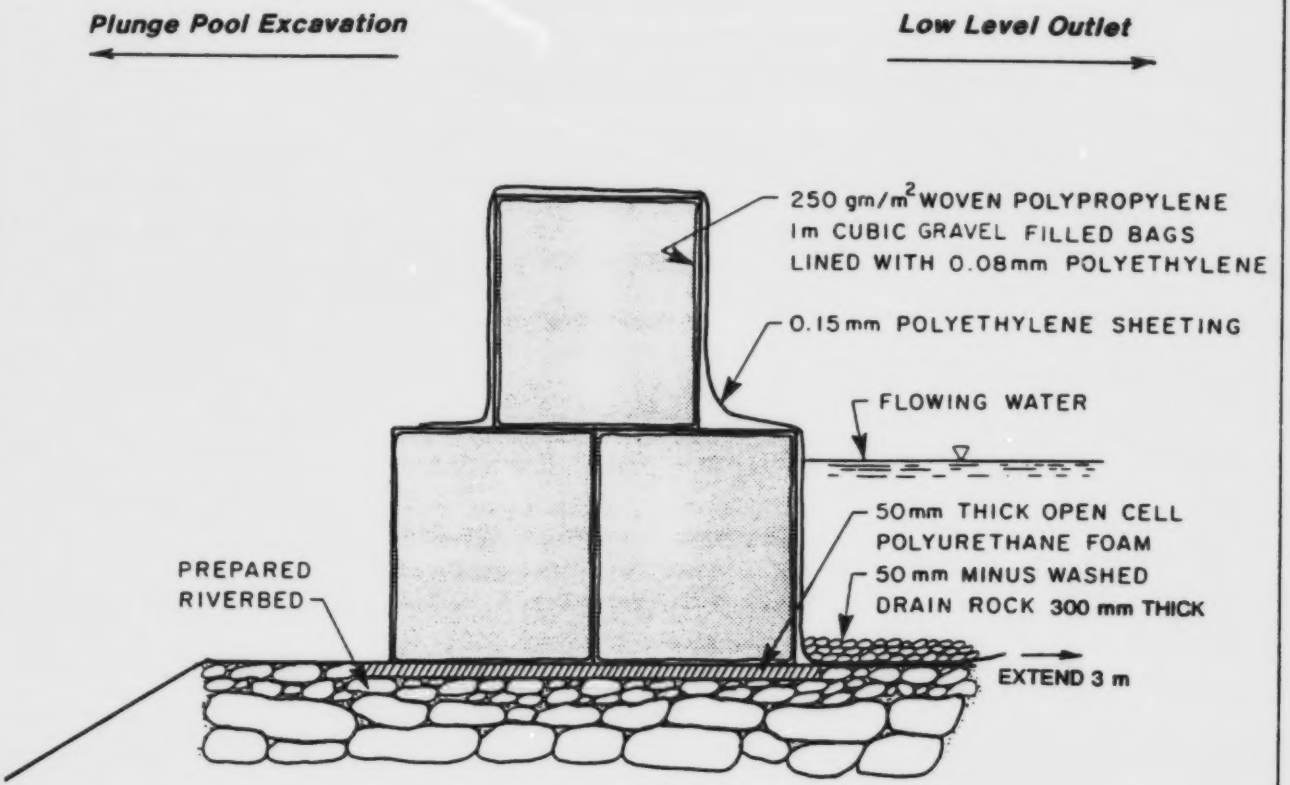

Anchor ropes or cables at access road
Permanent seed mix on loosened 0.15 m of native soil above plunge pool cut (use temporary cover mix above spillway cut)
2.5
1
Live pole drain where seepage encountered.
Excavated slope
Straw bales
1.0 m
1
1.5
300 mm
300 mm
Temporary 10 mm Polyethylene cover lapped into ditch.
500 mm
1
2.5
Interceptor ditch at 0.5% slope containing 50 mm rounded drain rock.
Spillway slope to be concreted
Tires to weight down polyethylene

Not to Scale.

PROJECT NO 902-1132 DRAWN C REVIEWED A.R. DATE July/90

DETAIL OF MODULAR CONTAINMENT DYKE INSTALLATION

Figure 7



Not to Scale.

NOTE : BAGS TO BE PLACED ONE OR TWO HIGH DEPENDING ON FREEBOARD REQUIREMENTS.

PROJECT NO 902-1132 DRAWN — REVIEWED AR DATE July/90

Appendix 6: RUNOFF AND SEDIMENT CONTROL PROCEDURES

Appendix 6 consists of a report, prepared for B.C. Hydro by Golder Associates Ltd., describes the sediment and runoff control procedures that will be implemented during the Alouete Spillway Rehabilitation project. Appendix A of of that report contains guidelines that have been used in the preparation of Appendix 9, Clearing and Excavation Rehabilitation Plan.

Golder Associates Ltd.
CONSULTING ENGINEERS

REPORT
TO
BRITISH COLUMBIA HYDRO
AND POWER AUTHORITY
ON
SEDIMENT CONTROL PROCEDURES
FOR
ALOUETTE DAM SPILLWAY
REHABILITATION PROJECT

DISTRIBUTION:

2 copies -	B.C. Hydro Vancouver, B.C.
1 copy -	Polster Environmental Duncan, B.C.
2 copies -	Golder Associates Ltd. Vancouver, B.C.

July, 1990

902-1132

JUL 11 1990

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
1.1	Project Description	1
1.2	Terms of Reference	2
1.3	Scope of Report	2
2.0	ENVIRONMENTAL OBJECTIVES AND DESIGN CRITERIA	2
2.1	Specified Water Quality Criteria	2
2.2	Specified Design Event	3
2.3	Implications of Sediment Control Objectives on Design	3
3.0	SEDIMENT CONTROL DESIGN CONSIDERATIONS	4
3.1	Timing of Construction	4
3.2	Reduction of Surface Runoff by Diversion	5
3.3	Protection of Exposed Slopes	5
3.4	Runoff Containment and Transport	5
3.5	Protection of Road and Work Area Surfaces	6
3.6	Treatment and Discharge of Sediment Laden Water	6
3.7	Runoff from Excavation Spoil Disposal Areas	6
3.8	Permanent Slope Protection and Re-vegetation	6
3.9	Rehabilitating Work Area and Plunge Pool After Construction	7
4.0	OPTIONS FOR TREATMENT OF SEDIMENT LADEN WATER	7
4.1	Disposal by Natural Percolation	7
4.2	Water Treatment	8
4.2.1	Settling Ponds	8
4.2.2	Chemical Treatment	8
4.2.3	Sand Filters	8
4.3	Disposal by Discharge into Lake	9
5.0	RECOMMENDED SEDIMENT CONTROL PROCEDURES AND DESIGN	10
5.1	Timing	10
5.2	Surface Runoff Diversion	10
5.2.1	Right Bank Access Road	10
5.2.2	East Valley Construction Road	11
5.3	Protection of Exposed Slopes	11
5.3.1	Left Bank Access Road Cut Slopes	11
5.3.2	Right Bank Cut Slopes	12
5.3.3	Cofferdam	14

5.4	Runoff Containment and Transport	15
	5.4.1 Left Bank Access Road	15
	5.4.2 Plunge Pool Excavation	15
	5.4.3 Right Bank Cut Slope	16
5.5	Protection of Road and Work Surface Areas	16
	5.5.1 Access Roads	16
	5.5.2 Work Areas	17
5.6	Treatment and Discharge of Sediment Laden Water	17
5.7	Runoff from Excavation Spoil Disposal Areas	18
5.8	Permanent Slope Protection and Re-vegetation	18
5.9	Rehabilitating Work Area and Plunge Pool After Construction	18
6.0	CONTRACTING AND SEQUENCING OF SEDIMENT CONTROL WORK	19
6.1	Temporary Protection and Maintenance of Work Areas	19
6.2	Water Handling and Water Treatment Facilities	19
6.3	Vegetative Treatment	20

LIST OF FIGURES

Figure 1	Site Alouette Lake Dam
Figure 2	General Arrangement of Sediment Control Measures
Figure 3	Schematic Flow Diagram of Water Handling System
Figure 4	Detail of Live Pole Drain Installation
Figure 5	Detail of Wattle Fencing Installation
Figure 6	Detail of Right Bank Interceptor Ditch
Figure 7	Detail of Modular Containment Dyke Installation

LIST OF APPENDICES

Appendix A	Report by Polster Environmental Services on Vegetative Treatment
Appendix B	Cost Considerations Related to Vegetative Treatment

1.0 INTRODUCTION

Rehabilitation of the Alouette Dam spillway will be carried out by the British Columbia Hydro and Power Authority (B.C. Hydro) during 1991. The spillway is located adjacent to the right abutment of the dam at the outlet of Alouette Lake approximately 75 kilometres east of Vancouver British Columbia as shown on Figure 1.

1.1 Project Description

According to B.C. Hydro's Environmental Management plan the spillway modification work will entail:

1) replacement of new spillway chute walls and invert, construction of a new terminal structure and riprap protection on the slopes of the stilling basin.

2) repair of the low level outlet headworks and the installation of an additional gate.

3) extension of the existing free crest ogee by replacing the existing gated sluices.

Preparatory work will begin in 1990 with the construction of an access road down the left river bank.

The rehabilitation work will result in the removal of 60,000 to 70,000 cubic metres of silt, sand, gravel, boulders and broken concrete and will result in the exposure of dense silty soils which underlie the valley walls and the existing spillway structure. The environmental impact of the work, particularly the impact on water quality and the downstream fish resource are of prime concern to B.C. Hydro.

The general layout of the site is shown on Figure 2. Throughout this report features are often discussed with reference to left bank or right bank. Convention dictates that these descriptions assume the site is viewed looking downstream, therefore the west bank is the right bank and the east bank is the left bank.

1.2 Terms of Reference

Golder Associates Ltd. (Golder) was retained by B.C. Hydro Geotechnical Department to provide specialist consulting services for sediment control under purchase order PCP000579. Work is being carried out in accordance with the requirements set out in B.C. Hydro's request for proposal dated April 11, 1990, and the scope of services outlined in Golder's proposal P90-1115 dated April 20, 1990. Golder Associates has retained Polster Environmental Services to provide specialized input on vegetative treatment.

1.3 Scope of Report

This report assesses sediment control concerns, discusses various options for addressing these concerns and provides recommendations for sediment control procedures and their implementation as an integral part of site rehabilitation work.

2.0 ENVIRONMENTAL OBJECTIVES AND DESIGN CRITERIA

B.C. Hydro has assembled a team of broadly qualified individuals to establish environmental objectives and design criteria for the project. This group, through discussion with the Department of Fisheries and Oceans, has established criteria for the quality of water discharged from the work area and the level of acceptable risk that those levels might be exceeded. The group has also established minimum acceptable water flow rates which must be maintained in the Alouette River downstream of the work area.

2.1 Specified Water Quality Criteria

According to the B.C. Hydro Environmental Management Plan, sediment control procedures will be implemented with the objective of limiting sediment release to <5 mg/L above background levels immediately downstream of the site we understand that some increase may be possible during the period from late July through early September. Direct field measurement of suspended sediment concentrations is not possible and the time lag between sampling and laboratory testing is unacceptable from a contract administration perspective. We understand therefore, that B.C. Hydro will calibrate the specified sediment

release criteria with Nephelometric Turbidity Units (NTU's), which can be measured in the field using a portable electronic monitoring device.

2.2 Specified Design Event

The B.C. Hydro Environmental Management Plan states that the sediment control procedures and water handling facilities will be designed to achieve the above objective for all conditions up to the 10 year storm. We understand that based on site specific hydrologic studies carried out by B.C. Hydro, the 10 year storm at Alouette Dam constitutes 157 mm of rain fall in 24 hours. Our calculations indicate that facilities must be designed with a throughput of approximately 4500 l/min to handle runoff from the entire work area.

2.3 Implications of Sediment Control Objectives on Design

The present discharge from the Alouette Dam is very clear with low levels of turbidity and suspended solids. Short term monitoring of the discharge in late 1989 and early 1990 suggests that the "normal" suspended solids level is <1 mg/L. This means that sediment laden water released from the work area into the Alouette River downstream of the work area must contain no more than 5 mg/L suspended sediment for all conditions up to the 10 year storm. This will be an extremely difficult objective to meet given the nature of the work which will be carried out, the subsoil conditions and the surface runoff intensity associated with the 10 year storm. This extremely strict sediment control objective has the following implications:

1) all runoff within the work area must be contained and pumped upstream through a water handling facility (no seepage from the work area can be permitted to enter the Alouette River directly).

2) excavation work will have to be sequenced such that any slopes or working surfaces are covered and protected from erosion as soon as practically possible after they are exposed.

3) work may have to be suspended periodically when wet (conventional allowances for wet weather days should be provided in the construction schedules).

The extremely strict objective for sediment release limits has predicated the sediment control design considerations discussed below. There are, however, several important items which should be highlighted. These are:

1) the timing of construction can be scheduled to avoid those periods of the year when extended wet weather is most probable;

2) the nature of the site is such that as work proceeds the potential for runoff containment increases (stilling basin excavation increases in size); and

3) Alouette Lake upstream of the site has a tremendous capacity to dilute sediment laden water generated by construction activities.

3.0 SEDIMENT CONTROL DESIGN CONSIDERATIONS

Water quality protection measures must be in place prior to the start of construction program and must be operated at all times right through the completion of the project. It is our opinion that a preventative approach to sediment control will be much more successful than extensive "after the fact" treatment efforts. Careful monitoring and strict enforcement of sediment control procedures will be required to meet the strict sediment release objectives established. Various design considerations are discussed in the following subsections.

3.1 Timing of Construction

Timing is an extremely important element in the control of sediment on any construction project but the project schedule and unpredictable weather conditions in the Alouette River Valley may make optimum timing of activities very difficult. Historically the late summer period between August 1 and September 15 has proven to be a relatively dry period with risk of heavy rain and erosion increasing towards the early winter period of December and January followed by decreasing risk through spring and early summer.

Construction of the initial access road down the left bank, establishing the plunge pool excavation work area at the base of the spillway and diversion of existing surface runoff away from the work site are likely to be the more critical phases of the project when the risk of uncontrolled sediment release is the highest. We concur with the proposed schedule to

construct the surface runoff diversion works and left bank access road during August and September, 1990. Throughout the course of construction, and particularly during the initial phases it must be recognized that wet weather could occur at any time and that certain construction activities should be scheduled to allow the flexibility to delay work temporarily until dry weather returns.

3.2 Reduction of Surface Runoff by Diversion

The Alouette Dam lies in the bottom of a steep walled valley which experiences a very high annual rainfall, intense peak rainfall events and periodic elevated surface runoff due to heavy rain on wet snow. As such, a considerable amount of runoff flows down the valley walls as creek flow and subsurface drainage. Naturally the amount of water that has to be handled in the excavation will depend to a great extent on the amount of surface and subsurface drainage which enters the excavation as well as runoff collected as the result of rainfall catchment within the work area. As much of the existing surface and subsurface flow on both sides of the valley should be intercepted and controlled as practically possible. This should be accomplished through diversion ditches on both sides of the valley and a dewatering well system around the perimeter of the excavation. These provisions are incorporated into the excavation design.

3.3 Protection of Exposed Slopes

Sequenced construction will be of considerable importance in the successful control of sediment during this project. Excavation of the spillway slab and spillway walls must be carried out in sections of restricted length so that both temporary and permanent erosion protection measures can be placed. Both temporary measures such as covering the slopes with polyethylene where subsequent permanent concrete or other covering will be placed, and permanent measures such as top down treatment of permanent excavation slopes with vegetation immediately behind excavation will be required.

3.4 Runoff Containment and Transport

During all phases of the work a drainage system within the work area will be required to separate "clean" water (water containing less than 5 mg/L suspended sediment) from

sediment laden water. Clean water can be discharged directly into the river. Sediment laden water collected in a sump in the plunge pool area will have to be pumped upstream for deep discharge into the lake. Separation will result in reduced requirements for pumping capacity at the plunge pool sump during heavy rainfall events and reduced volumes of sediment laden water discharged into the lake.

3.5 Protection of Road and Work Area Surfaces

Road and work area surfaces are the most susceptible locations for potential sediment production. Due to frequent movement of heavy equipment which may disturb the underlying fine grained soils, every effort must be made to protect these areas.

3.6 Treatment and Discharge of Sediment Laden Water

The nature of rainfall events at the Alouette Dam site, constraints of topography, limited working space and type of sediment likely to be generated essentially preclude water treatment. The sediment control measures must rely on minimizing sediment production, containment of sediment laden water within the work area and dilution of that water to acceptable sediment levels by deep discharge into Alouette Lake well upstream of the site.

3.7 Runoff from Excavation Spoil Disposal Areas

Runoff from the excavation spoil disposal areas is a potential secondary source of sediment; therefore, measures are required to prevent erosion and to contain runoff in these areas. We understand that spoil will be disposed on the east side of the lake upstream of the dam and upstream of the previously used spoil disposal areas.

3.8 Permanent Slope Protection and Re-vegetation

The sediment control procedures implemented during construction should be designed as part of a successional permanent re-vegetation plan whereby natural establishment of long term vegetation species follows from pioneer species planted for temporary protection. This is the philosophy on which the temporary erosion protection by

vegetation concept has been developed. A more extensive discussion of re-vegetation requirements is included in Appendix A prepared by Polster Environmental Services.

3.9 Rehabilitating Work Area and Plunge Pool After Construction

Following completion of construction, the work areas located below high water must be purged of sediment so that future spills of water from the lake will not flush high sediment concentrations down the River. This can be accomplished by allowing several rainfall to wash these areas with clean water to pick up the sediment for discharge from the large pool sump into the lake upstream. Work areas above high water should be cleared of gravel, rock and other construction debris, covered with topsoil and then seeded and planted.

4.0 OPTIONS FOR TREATMENT OF SEDIMENT LADEN WATER

We have completed evaluations of three alternate methods of disposal for sediment laden water which will be generated by spillway rehabilitation construction activities. These are:

1) disposal by pumping to an area of granular soil and allowing the water to disperse by percolation through the ground;

2) treatment of the water to reduce sediment load before discharge; and

3) disposal by direct discharge into the lake upstream of the dam where it would be diluted by mixing before returning to the river through the low level outlet.

4.1 Disposal by Natural Percolation

The topography and geology of the Alouette River valley in the vicinity of the dam are not suitable for disposal by natural percolation. Generally the soils underlying the benches on either side of the valley is very dense, have very high silt content and have extremely low permeability. Discharge of the volumes of water that could be generated during the 10 year storm design event would result in rapid saturation of the ground surface

and flow directly back downslope into the river. A rain on wet snow event could intensify the runoff peaks.

4.2 Water Treatment

There are three options for treatment of sediment laden water:

1) construct settling ponds;

2) install a chemical treatment plant utilizing flocculant technology; or

3) build a sand filter facility.

4.2.1 Settling Ponds

Field observations and a review of grain size analyses on samples of the valley wall soils indicate that settlement ponds are not a very attractive option. The very fine grained nature of the soils (silt and clay content) result in lengthy settling times. Ponds would have to be extremely large and holding times unacceptably long. Observations at existing settling ponds located elsewhere in the valley confirm this.

4.2.2 Chemical Treatment

The use of flocculants, though effective in removing suspended sediments from water, is not an attractive option for several reasons. There is uncertainty about the effects of flocculant residue on downstream fisheries and the "surge capacity" nature of the water treatment facility make the use of flocculants questionable. Sediment removal using flocculants works best under conditions of constant flow and constant sediment load where the chemistry of the system can be balanced to achieve optimum results with minimum loss of flocculant into discharge waters. The fluctuating nature of runoff volumes and sediment loads anticipated on this project is bound to cause frequent problems.

4.2.3 Sand Filters

The use of sand filters is not considered a viable option due to the anticipated levels of suspended particles in the sediment laden water. In addition, the fine particle size of the suspended sediments would result in extremely large installations of low permeability to adequately filter the water.

4.3 Disposal by Discharge into Lake

Direct discharge of sediment laden water into the lake upstream of the dam is considered to be the most attractive option for disposal of sediment laden water. Initial estimates suggest that decant from the plunge pool sump could contain between 500 mg/l and 1000 mg/l of suspended sediment during heavy rainfall events. It is anticipated that during the 10 year storm design event approximately 2250 l/min will be pumped from the plunge pool sump though it is recommended that the pumping system be designed to handle up to 4500 l/min.

In order to maximize dilution of the sediment laden water and minimize the potential for flow of this water directly back to the intake of the low level outlet we recommend deep water disposal at a location at least 600 metres upstream of the dam (upstream of the first major creek on the east side of the lake beyond the spoil disposal area). It is assumed that the low level outlet will carry approximately 35,000 l/min. Pumped discharge volumes to the deep water disposal will vary but will at all times be significantly less than volumes entering the lake from the nearby creek. It is anticipated that the flow regime within the lake will result in suppression of the sediment laden water in the deep cold part of the lake and that this water will migrate north up the lake away from the intake of the low level outlet.

Limnilogical work carried out by B.C. Hydro indicates that a distinct thermocline exists in the lake at approximate elevation 98 m. The low level outlet is at elevation 109 m. Water entering the low level outlet would appear to originate above the thermocline though flow patterns at the inlet are naturally quite complicated. Therefore the deep water discharge point should be below elevation 95 m.

Wind driven overturning of the thermocline has been observed periodically in the lake but the volumes of water involved are far greater than the volumes introduced which will be introduced into the lake and significant mixing and dilution will occur. The volume of sediment laden discharge water is less than one fifteenth of the volume flowing through the low level outlet. A schematic flow diagram is shown on Figure 3.

B.C. Hydro proposes to monitor the suspended sediment levels in the lake above and adjacent to the deep water discharge and there exists flexibility to move the discharge pipe further up the lake or to a different elevation within the lake to minimize mixing or migration towards the low level outlet.

5.0 RECOMMENDED SEDIMENT CONTROL PROCEDURES AND DESIGN

This section contains our recommendations for sediment control procedures which should be incorporated into the design. Methods of implementing these procedures during construction are discussed in Section 6.

5.1 Timing

plan major access road construction and major slope excavation during dry weather periods;

minimize the length of time that any excavation can be left open without erosion control protection;

do not commence excavation work if rainfall is exceeding 5 mm per one hour; and

suspend excavation work and proceed with erosion control measures immediately if rainfall exceeds 5 mm in one hour.

5.2 Surface Runoff Diversion

5.2.1 Right Bank Access Road

construct diversion ditch along up-slope edge of right bank access road;

place filter cloth and line ditch with stone where loose, soft or saturated soils are encountered during ditch excavation;

provide two percent cross slope on right bank access road to direct surface runoff into the diversion ditch;

place select granular sub-base material and crushed angular road surfacing material on right bank access road sub-grade to reduce erosion; and

place filter cloth in those locations where loose, soft or saturated soils are encountered during road construction to prevent pumping.

5.2.2 East Valley B.C. Hydro Access Road

construct creek diversion ditch along up-slope edge of east valley B.C. Hydro access road and divert creek flow south, away from left bank access road area (direct the flow into the next creek channel to the south without disturbing the creek channel);

place filter cloth and line ditch with stone where loose, soft or saturated soils are encountered during road construction during ditch excavation;

provide two percent cross slope on east valley B.C. Hydro access road to direct surface runoff into the creek diversion ditch;

place select granular sub-base material and crushed angular road surfacing material on east valley construction road sub-grade to reduce erosion; and

place filter cloth in those areas where loose, soft or saturated soils are encountered during road construction to prevent pumping.

5.3 Protection of Exposed Slopes

5.3.1 Left Bank Access Road Cut Slopes

minimize the extent of required excavation in natural materials along the left bank access road;

excavate 2H:1V cut slopes using backhoes to final grade in a series of benches of limited height avoiding excavation procedures which involve temporary rough cuts and subsequent trimming (do not end push with dozers);

where vegetative slope treatment is specified, roughen the upper 0.15 metres of dense soil on 2H:1V slopes to allow the development of a strong rootmass (work across the slope to create terraces rather than up and down the slope which would increase the possibility of creating erosion channels);

on the left bank access road cut slopes place erosion resistant grass and legume permanent cover seed mix and fertilizer (see Appendix A for mix composition) as soon as possible after slope trimming (make provision for watering if natural rainfall is insufficient to keep soil at field moisture capacity);

where seepage is encountered in left bank access road cut slopes place live pole drains to conduct seepage to drainage ditch at base of cut slope (see Figure 4);

place one row of wattle fencing faced upslope with silt fence material across the lower portion of the cut slope to intercept any sediment which might wash down the slope (see Figure 5); and

keep all personnel and equipment off the left bank cut slope for at least four to six weeks or until the grass and legume cover has become established (at that time seed the slope with woody species to establish permanent vegetation - see Appendix A for complete description).

5.3.2 Right Bank Cut Slopes

a. spillway cut slope

minimize the extent of slope open at any given time and always excavate immediately to final grade to avoid leaving intermediate unprotected slopes;

excavate from the top down on a 2.5H:1V slope using backhoes and establish a temporary bench approximately 4 vertical metres below the access road elevation (just above the top of the concrete spillway channel sloping wall);

develop a shallow interceptor ditch (sloping at 0.5 per cent north towards the reservoir) just above the elevation of the top of concrete into which temporary protection for the lower slope will be tied and into which drain rock will be placed (see Figure 6);

where seepage is encountered in upper right bank cut slope place live pole drains to carry the seepage to the shallow interceptor ditch;

where vegetative slope treatment is specified, roughen the upper 0.15 metres of dense soil on 2.5H:1V slopes to allow the development of a strong rootmass (work across the slope to create terraces rather than up and down the slope which would increase the possibility of creating erosion channels);

on the right bank spillway cut slopes place erosion resistant grass and legume temporary cover seed mix (see Appendix A for composition) and fertilizer as soon as possible after slope trimming (make provision for watering if natural rainfall is insufficient to keep soil at field moisture capacity);

demolish existing concrete and remove the remaining right bank excavation in vertical panels working from the upstream end of the spillway, placing drainage fabric as required in areas of seepage, filter cloth and temporary 10 mil protective polyethylene sheeting lapped into the shallow interceptor ditch and tied down with cables and/or ropes and rubber tires, immediately behind the advancing excavation;

place frequent manways in the form of wooden ladders or stairways to minimize the likelihood of foot traffic on the vegetated and protected slope surfaces and place place snow fencing between the manways to prevent construction materials from sliding down the protected slope (after four to six weeks seed the slope with woody species); and

remove the temporary 10 mil protective polyethylene sheeting on the lower slope immediately prior to forming the concrete spillway liner.

remove temporary vegetation cover immediately prior to placing vertical concrete, drain gravel and silt cap at crest of spillway wall

seed disturbed area with permanent cover seed mix

b. plunge pool cut slope

above the right bank plunge pool excavation excavate from the top down at a 2.5H:1V slope using backhoes and establish a temporary bench approximately 6 vertical metres below the access road elevation;

place one row of wattle fencing faced upslope with the silt fence material across the cut slope;

proceed with excavation at 2.5H:1V and establish a second temporary bench approximately 12 vertical metres below the access road elevation (just above the top of the plunge pool rip rap);

develop a shallow interceptor ditch (sloping at 0.5 per cent north towards the ogee) just above the elevation of the top of riprap into which temporary protection for the lower slope will be tied and into which drain rock will be placed;

where seepage is encountered in right bank plunge pool cut slope place live pole drains to carry the seepage to the shallow interceptor ditch below;

where vegetative slope treatment is specified, roughen the upper 0.15 metres of dense soil on 2.5H:1V slopes to allow the development of a strong rootmass (work across the slope to create terraces rather than up and down the slope which would increase the possibility of creating erosion channels);

place a second row of wattle fencing faced with silt fence material across the cut slope immediately above the top of the riprap to intercept any sediment which might wash down the slope;

remove the remaining right bank plunge pool excavation in vertical panels working from the upstream end of the spillway, placing drainage fabric as required in areas of seepage, filter cloth and temporary 10 mil protective polyethylene sheeting lapped into the shallow interceptor ditch above and tied down with cables and/or ropes and rubber tires, immediately behind the advancing excavation;

remove the temporary 10 mil protective polyethylene sheeting immediately prior to placing sand and gravel padding and the plunge pool riprap;

on the right bank plunge pool cut slopes place erosion resistant grass and legume permanent cover seed mix and fertilizer as soon as possible after slope trimming (make provision for watering if natural rainfall is insufficient to keep soil at field moisture capacity); and

keep all personnel and equipment off the right bank cut slope for at least four to six weeks or until the grass and legume cover has become established (at that time seed the slope with woody species to establish permanent vegetation).

5.3.3 Cofferdam

construct the upstream and downstream shells of the cofferdam using free draining select granular fill placed in horizontal lifts to create small terraces between lifts (do not end dump upstream or downstream or blade fill over the terraced slopes);

crown the travelled crest of the cofferdam to shed surface runoff and cap the cofferdam with crushed angular road surfacing material to prevent rutting; and

on the cofferdam sideslopes place erosion resistant grass and legume temporary cover seed mix and fertilizer (see Appendix A for composition) as soon as possible after slope construction if erosion develops

5.4 Runoff Containment and Transport

5.4.1 Left Bank Access Road

construct culvert lined ditch along the base of the left bank access road cut slope to intercept downslope drainage;

provide seepage cutoff collars beneath the culvert on approximately 20 m spacing to prevent erosion and piping if runoff gets beneath the culvert;

construct the left bank access road at 10 percent grade using coarse shotrock fill which will not erode (consideration may be given to placing filter cloth and/or a freedraining sand and gravel filter layer immediately against the slope to prevent washing of fines into the shotrock);

provide a two percent cross slope on left bank access road to direct surface runoff into the culvert lined ditch at the base of the cut slope;

place straw bale breakers at 20 metre intervals along the culvert lined ditch invert to filter any sediment laden water (the bales will require periodic replacement if they clog up with sand and silt sized sediment - clay size particles will not be filtered by the straw bales);

carry runoff from the ditch into catch basin and beneath the road through a pipe which will discharge into a holding sump on the upstream side of the roadfill from where it will be pumped to the plunge pool sump facility (if the discharge from the left bank access road ditch proves to be clean (less than 5 mg/l suspended sediment), the flow could be diverted at the pipe inlet and directed downstream into the river.;

install a culvert in the river channel to carry water clean seepage water from the upstream side of the roadfill to the downstream side; and

place a sandbag and polyethylene sheeted curb structure on the inside edge of the sharply curved portion of the access road to prevent sediment laden runoff from entering the creek (at this location the cross slope on the access road will be in an upstream direction).

5.4.2 Plunge Pool Excavation

dewater the plunge pool area sufficiently to allow backhoe equipment to work above water level while preparing a pad for the construction of a modular containment dyke along the right side of the low level outlet pipe;

place polyethylene sheets, polyurethane foam pads and gravel filled woven polypropylene sandbags end to end along the dyke centreline (see Figure 7 - consideration has been given to the use of sheet piles to construct the cutoff but the substratum is considered to be too dense and contains too many boulders to successfully install the sheet piles);

collect seepage and runoff water at the base of the right valley wall in a shallow ditch and direct it by pump to discharge downstream of the work area if it is clean (less than 5 mg/l suspended sediment), or into the central water handling facility if it is sediment laden;

create a sump in the lower left corner of the plunge pool excavation from all sediment laden water will be pumped for disposal upstream (the plunge pool excavation will create a surge storage pond for sediment laden water and will flood if the pumping system fails); and

install semi-submersible electric pumps with a capacity of 2250 litres per minute adjacent to plunge pool sump (calculations indicate that surface runoff within the work area will generate approximately 2250 litres per minute of sediment laden water during the 10 year return period design event and other runoff will be directed elsewhere as shown in Figure 3).

5.4.3 Right Bank Cut Slope

water from the upper 4 vertical metres of the right bank spillway and plunge pool cut slopes will be directed upstream via a shallow ditch to discharge near the right abutment of the cofferdam, therefore a sump and electric pump should be installed at this location to remove the flow from the excavation (if the discharge is clean it should be pumped up the slope, through a culvert beneath the right bank access road

and into the right bank surface runoff diversion ditch, if the discharge is sediment laden it must be directed to the plunge pool sump).

5.5 Protection of Road and Work Surface Areas

5.5.1 Access Roads

construct all access roads with a cross slope to direct surface runoff into ditches to reduce sediment transport along the road surface;

where access roads are constructed on soft or loose silty soils and/or where subgrade seepage is encountered, place filter fabric beneath select granular fill and crushed angular road surfacing material;

angular road surfacing material should consist of 19 mm minus well graded sand and gravel containing less than 5% fines - road surfacing should be produced by crushing to ensure high angularity and good binding;

on steep grades consideration may be given to placing asphalt surfacing to prevent rutting, and runoff erosion; and

carry out regular repairs on all roads to fill potholes, remove ruts and maintain cross slopes.

5.5.2 Work Areas

cover the lower right bank staging area with a 0.5 metre thick layer of clean crushed rock fill (the use of filter fabric beneath this layer is not recommended because of the difficulty associated with subsequent removal to re-establish the local fish habitat);

in the spillway channel and ogee block areas work in a sequential manner opening small sections of the excavation, trimming to final grade and placing surface treatment such as the sub-slab drainage layer or lean concrete immediately; and

do no permit equipment to travel directly on exposed native silty substratum unless material is protected by lean concrete or filter fabric and 0.3 metres of select granular material and 0.3 metres of clean crushed rock (placement of lean concrete may hinder sub-slab drainage and should be used in a manner compatible with the sub-slab drainage design).

5.6 Treatment and Discharge of Sediment Laden Water

pump sediment laden water from plunge pool sump upstream along the upslope side of the east valley B.C. Hydro access road to the deep water discharge facility;

discharge the sediment laden water into the lake through a dispersion pipe below elevation 95 m where it will be confined and diluted; and

monitor suspended sediment levels above and adjacent to the deep water discharge location.

5.7 Runoff from Excavation Spoil Disposal Areas

construct a granular fill containment dyke along the downslope edge of the spoil disposal area;

grade spoil to shallow slopes to reduce potential runoff erosion;

pump any sediment laden water which ponds behind the dyke into the deep lake discharge installation if it cannot be absorbed by seepage into the ground; and

work the disposal area in segments re-vegetating each segment immediately upon reaching maximum fill levels.

5.8 Permanent Slope Protection and Re-vegetation

details of recommended procedures and requirements are contained in Appendix A and were prepared by Polster Environmental Services.

5.9 Rehabilitating Work Area and Plunge Pool After Construction

excavate all loosened materials, construction debris and work area surfacing materials in retreat from plunge pool excavation;

allow several rainfalls to "wash" areas below high water to capture remaining loose sediments and pump sediment laden water to deep water discharge; and

place topsoil in areas above high water and seed and plant to re-establish vegetative cover.

6.0 CONTRACTING AND SEQUENCING OF SEDIMENT CONTROL WORK

The sediment control work on this project can be broken into three major components:

1) temporary protection of working areas and maintenance of the site to reduce generation of sediment;

2) water handling and disposal; and

3) vegetative treatment for both short and long term erosion protection.

All three components of the work will be required continuously throughout the duration of the project. The first two can be established as the general contractors responsibility but it is recommended that the third component be contracted separately because of the specialized nature of the work.

6.1 Temporary Protection and Maintenance of Work Areas

Requirements for protection of slope and working areas can be detailed on the contract drawings and in the construction specification. It should be recognized however that these aspects of the work will be detailed in a "method" specification rather than an "end product or performance" specification. The onus will be on the B.C. Hydro's construction inspection personnel to enforce timely compliance with the requirements, particularly the sequencing of work to ensure that excavation does not proceed too far ahead of protection measures. Model contract clauses have been provided to B.C. Hydro for review, modification and inclusion in the contract documents.

6.2 Water Handling and Disposal Facilities

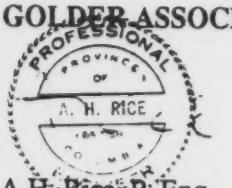
These facilities will be required from the start of construction in the summer and fall of 1990. It is recommended therefore that B.C. Hydro together with their own construction forces once the main construction contract is awarded the main contractor should be given

responsibility for operating and maintaining the facility to provide the contractor incentives to reduce sediment production within the working area. This will reduce his operating costs.

6.3 Vegetative Treatment

This is specialized work which will be required periodically throughout the project. The decision on when to carry out vegetation work should be left to the discretion of the B.C. Hydro and therefore it is recommended that the vegetation contractor work directly for the B.C. Hydro . The main construction contract will have to contain provisions which require the main contractor to permit the vegetation contractor "unhindered access to the site in a timely manner". Should it be preferable for the revegetation contractor to work as a sub to the main contractor we recommend that the sub be pre-qualified or designated by B.C. Hydro. A list of qualified contractors can be provided.

Report Prepared by
GOLDER ASSOCIATES LTD.



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Associate

I\AHR-1132

SITE OF ALOUETTE DAM

Figure 1

PROJECT NO 902-1132 DRAWN ... REVIEWED A.R. DATE July '90

Golder Associates

APPENDIX A

REPORT BY
POLSTER ENVIRONMENT SERVICES
ON
VEGETATIVE TREATMENT

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
	1.1 Program Objectives	1
	1.2 Program Philosophy	2
2.0	RECLAMATION PRESCRIPTIONS	4
	2.1 Temporary Cover Establishment	4
	2.2 Permanent Cover Establishment	6
	2.2.1 Site Preparation	6
	2.2.2 Grass and Legume Seeding	7
	2.2.3 Woody Species Establishment . .	9
3.0	SEDIMENT CONTROL	12
	3.1 Straw Bale Dikes	12
	3.2 Plastic Coverings	14
	3.3 Other Measures	15
4.0	CONDUCT OF THE WORK	15
5.0	CONCLUSIONS	19

1.0 INTRODUCTION

This report outlines measures which can be taken to minimize sediment generation and to reclaim and revegetate the disturbances associated with planned modifications to the spillway of the Alouette Dam. This report has been prepared by Polster Environmental Services at the request of Golder Associates Ltd. The report is organized to present the reclamation and sediment control objectives and philosophy, to provide recommendations for revegetation, to present sediment control recommendations as well as scheduling for all activities. Requirements for maintenance are presented in the final section of the report.

1.1 Program Objectives

Long term objectives for the sediment control and reclamation program entail minimizing sediment generation through a program of effective reclamation. During construction, sediment laden waters will be separated from "clean" water and treated at a location away from the construction area. Specific reclamation objectives are as follows:

1. Reclamation will seek to provide a permanent cover of vegetation on the disturbed sites through the integration of the disturbed sites into the natural processes of vegetation succession.
2. Reclamation design will provide for maximum sediment control without constraining future vegetation growth and development.

1.2 Program Philosophy

The sediment control and reclamation programs are based on the philosophy measures which will avoid and/or minimize impacts are far more effective than measures designed to treat impacts once they occur. For this reason measures which will reduce the extent of sediment generation and which will promote the long term development of a vegetation cover are recommended.

The reclamation program has as its basis the re-establishment of the natural successional processes. Successional reclamation, the term applied to this approach to reclamation, seeks to define those parameters which would prevent the natural successional processes from developing and to provide a biotic setting appropriate for the advancement of the successional processes.

There are three basic steps to achieving an effective successional reclamation program. These are:

1. Provision of a substrate which is suitable for plant growth and which will remain in place long enough for vegetation to become established.
2. Providing "space" for new plant species to invade and establish in the cover of the plants which have established initially.
3. Providing initial plant species which enhance the ability of later successional species to establish and develop.

An understanding of the basic successional processes which operate in an area is important in designing an effective successional reclamation program. In the Alouette Dam area, succession on soils (primary succession on rock is not important in this context) is initiated with the establishment of a cover of herbaceous species and pioneering trees and shrubs. Grasses and "weedy" species such as thimbleberry, red alder, and big leaf and vine maple invade bare soil sites soon after the site has become stable physically. Later, once the soils and site conditions have been ameliorated by the growth and development of these species, conifers such as Douglas fir and hemlock invade. Eventually, an assemblage of vegetation which will perpetuate itself in the long term (climax vegetation) will develop on the site. Attempts to plant these later successional species prior to the site being ameliorated by the earlier successional vegetation will meet with limited success.

Recreation of the successional stages outlined above will ensure that the reclamation efforts at the Alouette Dam site will meet with success. Details of the measures which are recommended for disturbances associated with the reconstruction of the spillway are presented in the following section of this report. Reclamation scheduling is presented in section 4.0.

2.0 RECLAMATION PRESCRIPTIONS

2.1 Temporary Cover Establishment

Exposed, erodible surfaces which will be in place for six months or more should be seeded to a temporary cover of grasses and legumes as they are built. This would include the coffer dam, the non-permanent slopes of the access road, the waste materials containment structure, and the perimeter of all construction areas. This will minimize the extent of area where sediments could be generated during extreme rainfall events and will provide some conditioning of the soils prior to eventual reclamation.

The temporary vegetation cover may be established by hydroseeding the sites. A seed mix composed of rapidly developing species is presented in Table 2-1. The seed should be applied at a rate of 50 kg/ha along with fertilizer and wood fibre mulch. The fertilizer (19-18-19) should be applied at a rate of 350 kg/ha while the mulch should be applied at a rate of 200 kg/ha. Care should be taken prior to seeding to ensure that the soil surface is loose and rough so that the seeds may become lodged in the cracks and crevices for germination and early growth. Seeding should be conducted to overlap the seeded vegetation with any existing vegetation adjacent to the site being seeded. Some consideration should be given to providing water

TABLE 2-1

ALOUETTE DAM SPILLWAY REHABILITATION
RECLAMATION SEED MIXES

Temporary Cover Mix

Variety, Species	Percent by Species Composition	Percent by Weight
Barlano Perennial Rye	20	37.56
Climax Timothy	15	6.08
Kay Orchardgrass	10	10.52
Boreal Creeping Red Fescue	15	12.72
Geronimo Kentucky Bluegrass	10	2.82
Aurora Alsike Clover	15	10.41
Ladino White Clover	5	3.04
Pacific Double Cut Red Clover	10	16.85

Permanent Cover Mix

Boreal Creeping Red Fescue	15	10.03
Climax Timothy	10	3.19
Kay Orchardgrass	20	16.59
Tall Wheatgrass	5	25.39
Reubens Canada Bluegrass	10	1.91
Geronimo Kentucky Bluegrass	5	1.12
Pacific Double Cut Red Clover	15	19.93
Ladino White Clover	10	4.79
WL 225 Alfalfa	10	17.05

Perennial Lupines should be added to permanent cover sites at a rate of 5 kg/ha.

for irrigation if sites are seeded in June, July and August. Silty water from the construction areas could be used for this purpose, although care will be required to ensure the sites are not watered to the point where the water runs off, causing additional siltation.

Establishment of a temporary cover of vegetation on disturbed sites will be the first line of defence against sediment generation. A seeded cover which will effectively reduce raindrop, sheet and rill erosion, can be established in 4 to 6 weeks, given reasonable moisture and sunshine. By seeding sites during periods of dry weather, the risk of serious rainfall events is minimized. However, irrigation water would be required to ensure proper plant establishment. On-site personnel, charged with maintaining the environmental integrity of the project as a whole can be charged with the responsibility of ensuring such an irrigation system is functioning properly.

2.2 Permanent Cover Establishment

2.2.1 Site Preparation

The first step in the development of a permanent cover on the reclamation areas will be to prepare the sites for revegetation. Cut and fill slopes should be left with a loose surface. In the case of cuts, this may

require ripping the surface after the cut is complete. The surface of both cuts and fills should be left in a rough state. Smooth grooming of sites, other than lawn areas, which are to be reclaimed, leads to greater erosion and a poor catch with the seeded species.

There is a significant advantage in the use of topsoil in the revegetation of disturbed sites. In particular, cut slopes in the Alouette Dam area would benefit from an application of locally derived topsoil. Topsoil should be firmly keyed into the underlying slope so that it does not tend to slump off the slope. In some cases, where there is an excess of groundwater exiting from the cut slopes, live pole drains, discussed in Section 2.2.3 of this report, can be used to control groundwater seepage zones and establish a cover of woody species. As with other site preparation techniques, topsoil should be left in a loose and rough condition.

2.2.2 Grass and Legume Seeding

Sites which have been graded into their final configuration should be revegetated with their permanent vegetation cover. The permanent cover has been designed to recreate the natural patterns of vegetation succession. Table 2-1 presents a seed mix which would be effective in the Alouette Dam area.

This seed mix would result in the establishment of an open cover which will allow the invasion of the site by woody trees and shrubs. The inclusions of perennial lupines in the permanent cover should be considered in areas which will be viewed by the public. Lupines may be added to the permanent seed mix at a rate of 5 kg/ha.

On sites, such as the waste materials area, where slopes are less than about 15^{o}, the seed and fertilizer may be applied with a tractor. The seed and fertilizer should be lightly harrowed into the soil surface with a pipe-stem or chain harrow. With tractor seeding, the seed should be applied at a rate of 75 kg/ha. A balanced fertilizer, 19-18-19, should be applied at the time of seeding at a rate of 300 kg/ha.

Sites where slopes are greater than 15^{o} should be seeded using a hydroseeder. Seed and fertilizer should be applied at the same rates as for tractor seeding. A wood fibre mulch should be applied with the seed and fertilizer at a rate of 400 kg/ha.

Seeding should be conducted as soon as sites are available. In some cases it is advantageous to seed cuts as they are brought down. This is particularly true where the cut will be completed some time before

the completion of the project, such as the cut slope adjacent to the spillway. As with the temporary cover, the availability of irrigation facilities will ensure that seeded sites develop a vegetation cover quickly.

2.2.3 Woody Species Establishment

The final step in the active reclamation of disturbed sites associated with the Alouette Dam rehabilitation project will be the establishment of pioneering woody species. Woody species may be established from seed or from rooted container grown plantings. In the case of willows and cottonwoods, hardwood cuttings, taken during the dormant season, can be used to get the plants established. Seed is recommended as the method of choice for the establishment of red alder and maple. Pioneering conifers, such as Douglas fir and hemlock should be established from rooted, container grown stock.

Seed for the red alder and big leaf maple should be collected in the late summer or early fall when they become ripe. The seed should be sown as soon as possible after collection. This is particularly true of the maple, where storage of the seed will significantly reduce viability. Alder seed may be stored without significant loss in viability.

Alder seed is relatively small, with over 2,500,000 seeds per kilogram, while maple has one of the largest seeds of any British Columbia tree species. Alder seed should be applied at a rate of 1 kg/ha, while the maple seed should be applied at a rate of 5 kg/ha. Maple seed should be hand broadcast, while the alder seed can be applied with a hydroseeder. Both of these species should be seeded onto the reclamation sites as soon as the seed becomes available.

Conifers may be obtained from local nurseries, such as Hybrid Nurseries in Pitt Meadows. Douglas fir and hemlock should be planted on the reclamation sites at a combined rate of 3,000 stems per hectare. It may be prudent to order stocks of both Douglas fir and hemlock as soon as possible, for planting when the work on project sites is complete. It is estimated that about about 3,000 plants of each species will be sufficient to provide effective reclamation. It should be noted that the reclamation program has been designed so that conifers will naturally seed in from adjacent stands. However, planting of container grown stock will hasten the eventual establishment of a conifer cover.

Willow and cottonwood cuttings can be collected at any time when the plants are fully dormant. In general, cuttings should be planted as soon as possible after

collection. However, cuttings may be stored in moist sawdust over the winter, if there is some reason why they can not be planted at the time of collection. Cuttings should be planted while they are still dormant and while the local flora is dormant. Planting of cuttings during the summer, when the local willows are not dormant will put a physiological stress on the cuttings which would result in unacceptable mortality.

Specialized bioengineering techniques can be used to perform particular reclamation functions. Live pole drains, where bundles of willow and cottonwood cuttings are used as a drain, can solve minor soil moisture problems and result in the development of a stand of these moisture loving species, exactly what would be predicted in a natural setting. Short retaining walls built of living cuttings can be used to stabilize steep slopes. These are called wattle fences. Wattle fences and live pole drains can be used for specific purposes in a reclamation program. However, where techniques are available to solve the problems treated with these bioengineering solutions, such as flattening a slope, such solutions should be incorporated in the engineering plans for the site. Bioengineering solutions should be employed where the cost and/or the effectiveness of other solutions is in question. Specific designs are required for bioengineering.

3.0 SEDIMENT CONTROL

The primary emphasis for control of sediments will be the inclusion of measures designed to minimize the generation of sediments. Temporary seeding, described above, is one such measure. Other techniques, discussed below, can be employed to minimize the generation of sediments and to prevent sediment transport to local waterbodies. Proper planning and judicious use of relatively simple techniques can reduce the risk of excess sedimentation to a minimum. The following sections provide details of some of the sediment control techniques which could be employed on the Alouette Dam construction.

3.1 Straw Bale Dikes

Sediment generation and movement can be controlled by constructing simple straw bale dikes. Small dikes made from wheat or flax straw bales can be used in ditches, across slopes or in any location where there is a potential for soil loss due to erosion. Grassland hay bales can be useful as an additional source of seed. The straw bales should be firmly seated in the substrate so that water does not flow around the bales, but slowly seeps through the bales. On steep slopes, or in ditches where a significant quantity of water may flow, the bales may be held in place with wooden stakes.

Straw bale dikes are recommended for use on cut and fill slopes with a slope length of 10 meters or more. In such cases, the slope length, which has a direct bearing on the potential erosion, can be split in half by constructing a straw bale dike across the centre of the slope. Straw bale dikes are also recommended for ditches, such as along the access road on the left bank, where invert slopes are greater than 5 percent. In the case of ditches, the dikes should be built at intervals along the ditch so that the water which ponds behind one dike (the top of the bales) just reaches the toe of the dike above.

Straw bale dikes may also be helpful in the clarification of sediment laden water. Ponding areas, constructed with straw bale dikes can aid in the treatment of discharge water. In this case, straw bale dikes can become a useful addition to the sediment treatment facilities.

Straw bale dikes need not be removed from slopes or ditches once the construction is complete unless the ponding area becomes completely full of sediments. In most cases, reclamation can be conducted around the dike, with the dike remaining in place as the vegetation becomes established. The straw bales will slowly deteriorate as the vegetation takes over the

role of sediment control. In the case of ditches where the dikes become full of sediments, cleaning the ditches with a backhoe during periods of dry weather, and the construction of new dikes will provide continuing protection. Again, as the straw bales are a source of organic material, they need not be separated from the sediments, but may be disposed of in a suitable location and revegetated.

3.2 Plastic Coverings

Plastic sheeting can be used as a temporary cover for exposed soil slopes to control erosion. It is understood that this technique is being considered for the soil slope along the spillway prior to the placement of concrete. Care should be taken in the joining of a plastic covered slope to one which is not plastic covered (as in the case of the spillway slope) to ensure water does not run under the plastic or otherwise compromise its effectiveness. A trench cut along the top of the concrete works along the spillway into which the plastic is laid and which is filled with rounded stone, will provide a good means of joining these two areas. Vegetation which is established on the upper portion of the slope can be overlapped into the stone area, and the plastic can be laid in such a manner that the water is directed to flow into the drains which will be installed behind the concrete

spillway. Design of such a facility should accommodate the planned drainage behind and below the spillway and should be made so that removal once construction is complete is not required.

3.3 Other Measures

Bioengineering techniques, such as living baffles, brush matting and grassed waterways can be used in certain circumstances to control erosion and sedimentation. Protective measures such as gravel blankets, rock lined ditches and the use of filter fabrics can aid in controlling sediments. Such techniques should be incorporated to treat specific problems. Design of these systems is site specific and should be conducted as the problems are identified.

Control of erosion and sedimentation as discussed in this report should minimize the need for these special measures. However, should problems arise, the prompt treatment of the problem with an effective solution will result in minimizing impacts associated with erosion and sedimentation.

4.0 CONDUCT OF THE WORK

The framework on which reclamation and erosion control programs are built has a significant impact on the effectiveness of the programs. The following

paragraphs provide recommendations on the manner in which the work detailed in this report is conducted. It is recognized that each construction project will have its own specific organizational structure, tailored to suit the project. As such, some of the suggestions contained in the following paragraphs may not be as appropriate as others. The recommendations are offered here as general guidelines, the exact workings of which may or may not have applicability to this project.

The inclusion of an environmental monitor on the project team can provide a means of dealing with minor environmental matters prior to their becoming major. It is suggested that such a person have a background in aquatic biology and that she report directly to the project manager. This person would be responsible for overseeing the day to day construction activities from an environmental perspective and would implement environmental protection procedures in a timely manner. This person could also act as a liaison between the project engineering staff and local government personnel in dealing with permit requirements, water sampling and other regulatory matters. The environmental monitor would act to ensure that terms and conditions of the contracts which related to environmental protection were followed.

Contracts for the work should be prepared to include erosion protection measures. The construction contractor should be responsible for the installation and maintenance of straw bale dikes, plastic sheeting and other erosion control measures. A revegetation contractor should be on the job with the start of construction to provide temporary seeding and to seed sites which are complete as they are completed. Access for the revegetation contractor must be specified in the contract governing the construction contractor. The construction contractor should be responsible for preparing the sites for revegetation. This would include all ripping, topsoil placement, site grading and other measures which are required prior to application of the seed.

The revegetation contract should be structured to allow for continual and progressive reclamation over the course of the work. This may result in having to pay a slight premium, as the contractor will seed small areas as they become available rather than waiting until all of the work is complete and seeding the whole area. However, in this situation, where heavy rainfall and the sensitivity of the river dictate, the establishment of a vegetation cover as soon as possible is worth the small premium which may result. Some means of having the revegetation contractor on contract to provide

bioengineering and other remedial measures as they are needed would be a benefit. It may be that by including a rate for hand labour in the contract would cover most of what would need to be done. This could be under the direction of the environmental monitor.

Scheduling will be the key to effective reclamation and erosion control on this project. On-site personnel, such as an environmental monitor, will have the best knowledge of when the different activities should be carried out. With some minor exceptions such as bioengineering and woody species seeding, all of the work outlined in this report could be carried at any time of the year. Irrigation, as noted previously, should be provided for sites seeded during periods of dry weather.

Some means of providing the environmental protection work with the attention which will be required to do an effective job should be included in the structure for the project. It is recognized that although the costs for the environmental protection measures outlined in this report are relatively small compared to the total project cost, careful attention to these matters will be required to ensure the project as a whole runs smoothly and that there are no needless delays. Environmental matters can impact project schedules

significantly if they are not dealt with in an appropriate manner. This needs to be recognized early in the planning process in order to ensure proper measures are taken.

5.0 CONCLUSIONS

Reclamation and sediment control will form an integral part of the rehabilitation work on the Alouette Dam spillway. Measures detailed in this report will minimize the impacts of development if they are implemented in a timely fashion.

Reclamation designs have been developed to mimic the natural patterns of vegetation succession on disturbed sites. The resulting vegetation cover will form a permanent and productive protection to the Alouette River and the engineering works of the dam.

Sediment control recommendations have been designed to minimize the generation of sediments and to control the movements of sediments into areas where they may harm the natural environment. Care in the implementation of these measures will be required to ensure they are effective at performing their functions and to ensure that they are in place in a timely manner. Proper reclamation and sediment control will ensure that the project runs smoothly with no serious disruptions.

APPENDIX B

COST CONSIDERATIONS
RELATED TO
VEGETATIVE TREATMENT

Polster Environmental Services.

R.R. No. 2, 4007 Lanchaster Road, Duncan, B.C., V9L 1N9 • Telephone (604) 746-8052

May 31, 1990

Mr. Anthony H. Rice, P.Eng.
Golder Associates Ltd.
224 West 8th Avenue
Vancouver, B.C.
V5Y 1N5

FAX (604) 879-5014

Dear Tony,

Re: Estimated Costs for Reclamation of Alouette Dam Project

Further to our meeting and site visit of yesterday, I am pleased to provide the following estimate of costs, quantities and methodologies for reclamation of the areas which will be disturbed during the proposed construction work on the Alouette Dam. From our discussions, I understand that there will be two major areas which will require reclamation treatments; the cut above the spillway on the right bank, and the access road cut on the left bank. Reclamation will also be required for the staging area on the right bank near the plunge pool, the waste storage area, a small area of slumping sod on the right bank, and a small area along the left bank of the spillway. I have also outlined below some thoughts on the control of sediments during construction.

Construction of the access road is scheduled to begin later this summer. A coffer dam will be built across the upper entrance to the spillway to prevent water from flowing through the work area as the road and other construction activities are underway. I would suggest that in cases where temporary structures are to be built which would be in place for 6 months or more, that seeding these sites will reduce sediment generation generally. A quick growing, inexpensive seed mix will be designed for this purpose. I have estimated that, in total, there may be as much as 2 ha. of temporary seeding required throughout the term of the job.

Reclamation design for the access road slopes will entail the establishment of an erosion resistant cover of grasses and legumes which will set the stage for the establishment of pioneering woody species later in the reclamation sequence.

.../2

The seeding should be conducted as soon after the cuts are made as possible. It may be prudent to allow for watering of the freshly seeded area if the natural rainfall is insufficient to keep the soil at field moisture capacity. The seed mix which will be developed for the site will be a relatively open mix which will allow red alder to be seeded onto the site as seed becomes available. Perennial lupines can also be seeded onto the site to add colour and aid in the fixation of nitrogen.

The cut on the right bank, adjacent to the spillway, as well as the cut on the opposite side of the spillway should be seeded with the open cover grass and legume mix as soon as the cut is opened up and ready for seeding. Live pole drains should be installed in areas of this cut where soil moisture would otherwise cause slope distress. A system of installing the geotextile and plastic covering, consisting of a trench about 0.5 m deep into which the fabric and plastic is laid, and which is backfilled with 5 cm stones, can be used to tie the revegetated slope drainage into the system of drainage which will be installed behind the concrete of the spillway. As with the other sites, a system for irrigation of the seeded areas should be considered to promote the growth of vegetation.

All of the sites to be reclaimed should be in a loosened state prior to seeding. The upper 0.15 m of the slope surface should be ripped so that the plant roots can grow freely. The slope surface should be rough, with microsites to catch and hold the seed. Ripping should be done across the slope, along the contours so that channels are not developed which would increase erosion. Surface preparation should be conducted as part of the grading contracts as access later in the reclamation stage may be difficult. Care should be taken in the grading to avoid creating a smooth surface, a rough, uneven surface will be much better for revegetation and erosion control.

Straw bale dikes can be used to reduce erosion and control sediment laden water in ditches and along exposed slopes. Straw bales are placed across the ditch or slope to form small catchment structures. Sediment laden water collecting behind the dike filters through the bale, loosing most of the suspended solids. Very fine clay sized particles will not be filtered by a straw bale dike. However, filter cloth could be added to increase the efficiency of sediment capture.

.../3

The slope area adjacent to the low level discharge where seepage problems are causing slope distress could be treated with live pole drains. However, it may be prudent to think of resloping the lower portion of this site with a blanket of gravel and/or rock, followed by a capping of till to act as a growth medium. I expect that there will be materials available during construction which could easily be placed in this area. This would provide a better solution than the live pole drains in this case. I have, however, included an estimate of the live pole drains which would be required for this site.

I understand that excavated materials will be placed on the left bank of the reservoir, upstream of the dam. This waste area can be reclaimed using the open cover grass and legume seed mix and the alder seeding as for the slopes. It may be prudent to install straw bale dikes on the downstream face of the waste area so that any sediments generated during construction of the waste area are trapped prior to entering the lake.

The following table outlines the expected quantities and associated costs for reclamation of the above sites. It should be noted that site preparation and any earthworks are not included in the reclamation costs.

Estimated Costs and Quantities
Alouette Dam Reclamation Program

Temporary Erosion Controlling Seeding

Item	Quantity	Unit Cost	Total Cost
Seeding	2 ha	$800/ha	$1,600.00

Access Road Reclamation

Grass and Legume Seeding	0.75 ha	$1,200/ha	$900.00
Red Alder Seeding	0.75 ha	$4,000/ha	$3,000.00
Live Pole Drains	300 LM	$25/LM	$7,500.00

.../4

Spillway Cuts Reclamation

Grass and Legume Seeding	0.75 ha	$1,200/ha	$900.00
Red Alder Seeding	0.75 ha	$4,000/ha	$3,000.00
Live Pole Drains	400 LM	$25/LM	$10,000.00

Waste Area Reclamation

Grass and Legume Seeding	1.5 ha	$1,200/ha	$1,800.00
Red Alder Seeding	1.5 ha	$4,000/ha	$6,000.00

Work Area/Staging Area Reclamation

Grass and Legume Seeding	0.5 ha	$1,200/ha	$600.00
Red Alder Seeding	0.5 ha	$4,000/ha	$2,000.00
Willow Cuttings Planting	1,000 pcs	$0.60/pc	$600.00

I hope that this information is of use to you. As you can see, if you budget $50,000 for the reclamation, you could do an excellent job. I think if a contract is put together for this work, some requirements for remedial, special work ("as directed by the Engineer") should be included so that we could do some extra things which may be needed but can't be determined at present.

Please give me a call if you have any questions. Thank you for inviting me to participate in this exciting project. I think that we could do an excellent job on the site, and that erosion and sedimentation could be very effectively controlled.

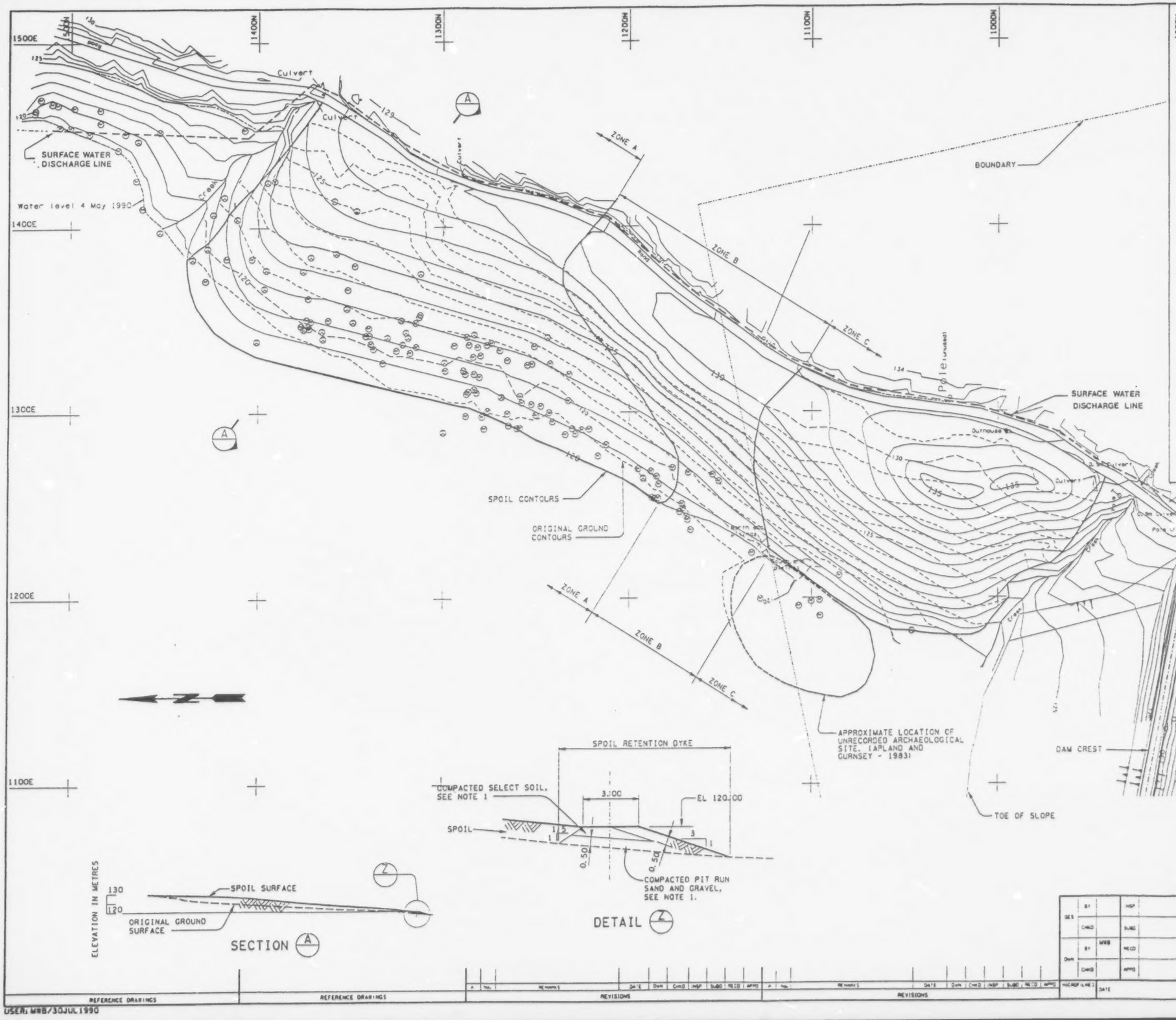
Sincerely,
POLSTER ENVIRONMENTAL SERVICES

David Polster

David F. Polster, M.Sc., R.P.Bio.
Plant Ecologist

Appendix 7: SPOIL AREA REHABILITATION PLAN

Specifications for placement of approximately 60,000 to 70,000 m^3 of spoil material, consisting of broken concrete, sand and gravel and silt are included in the Spoil Area Rehabilitation Plan, Drwg. 7-1.



SPOIL AREA - CONSTRUCTION NOTES:

- Spoil material will be evenly graded and contoured as shown.
- A dyke is to be constructed to contain fine spoil material as specified in Details A and Z.
- Broken concrete to be placed on the B.C.Hydro portion of the spoil area wsith a minimum cover of 1.0m
- All stumps that will not be covered by a minimum of 1m of material are to be removed and disposed of.
- Maximum grades are:

  Zone A
  Between El. 125 and 120. - 8%
  Between El. 130 and 125. - 10%

  Zone B
  Above El. 125 - Existing grades to be maintained
  Below El. 125 - 10% to 16%

  Zone C
  Between containment dyke and El.130 - 16% to 20%
  Above El. 130 - variable (16% max)

- Material placed between El. 125 and 120 to be capped with a minimum of 0.5m of sands and gravel.
- Material placed above El. 125 to be capable of supporting vegetation. The area will be capped with topsoil salvaged from other construction areas or will be enhanced with fertilizer to ensure plant growth.
- Material placed above El. 125 to be seeded with a mixture grass as specified by the Ministry of Parks.
- Drainage ditches along the upper edge of the access road are to be ennanced to carry runoff to the perimeter of the spoil area.
- Spoil material will not be placed or heavy equipment operated on the area indicated as an archeological site.

PRELIMINARY
DESIGN CHECK | INFORMATION
1 2 3 DRAFT
DATE 19

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
ALOUETTE DAM REHABILITATION
SPOIL AREA
PLAN AND DETAIL
SCALE AS SHOWN
DWG No. FIG 7-1 R

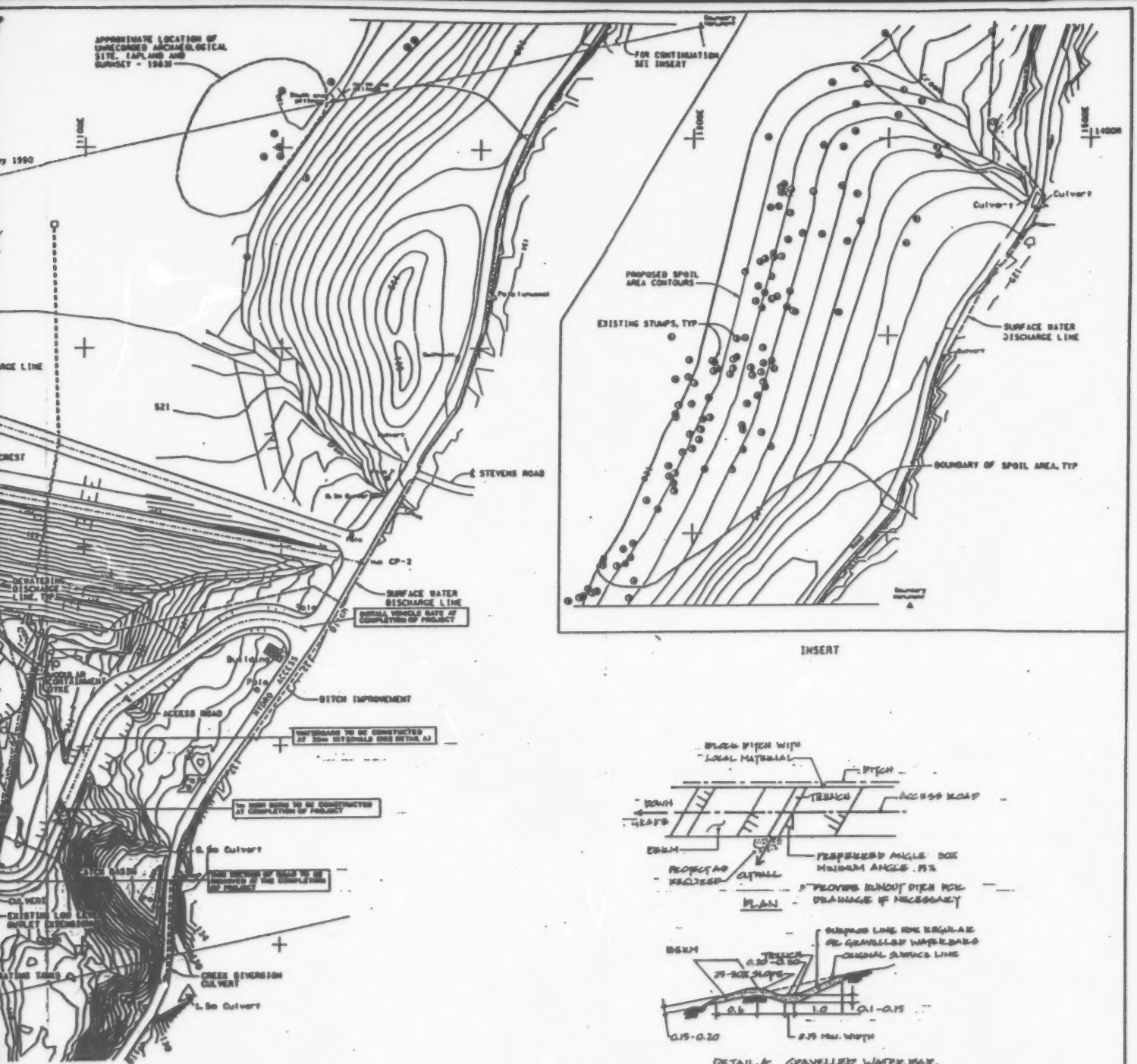
REFERENCE DRAWINGS | REFERENCE DRAWINGS | REVISIONS | REVISIONS

USER: MWB/30JUL1990

Appendix 8: ACCESS LOCATION AND REHABILITATION PLAN

The following plan Drwg. 8-1 shows the location of proposed site roads, sections that will be removed following construction and measures that will be implemented to control runoff on road surfaces.

Edge of water 7 May 1990
TEMPORARY COFFERDAM (DETAILS NOT SHOWN)
BOUNDARY
DISCHARGE LINE
6m WIDE VERTICAL LIFT GATE
DAM CREST
PARKING AREA
FENCE
DOUBLE GATE
DITCH
ACCESS ROAD
DISCHARGE LINE, TYP.
SPILLWAY CONFERENCE LINE
STILLING BASIN
OBSERVATION WELLS
DRILL PAD, TYP.
WORK AREA
REMOVE THIS SECTION OF ROAD AND CONSTRUCT PARKING LOT AND FENCE AS SHOWN
RESTORE PARKING LOT ROAD AT COMPLETION OF PROJECT
1100N
1000N
900N
700N
100E
200E



DETAIL A GRAVELLED WATERBAR

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

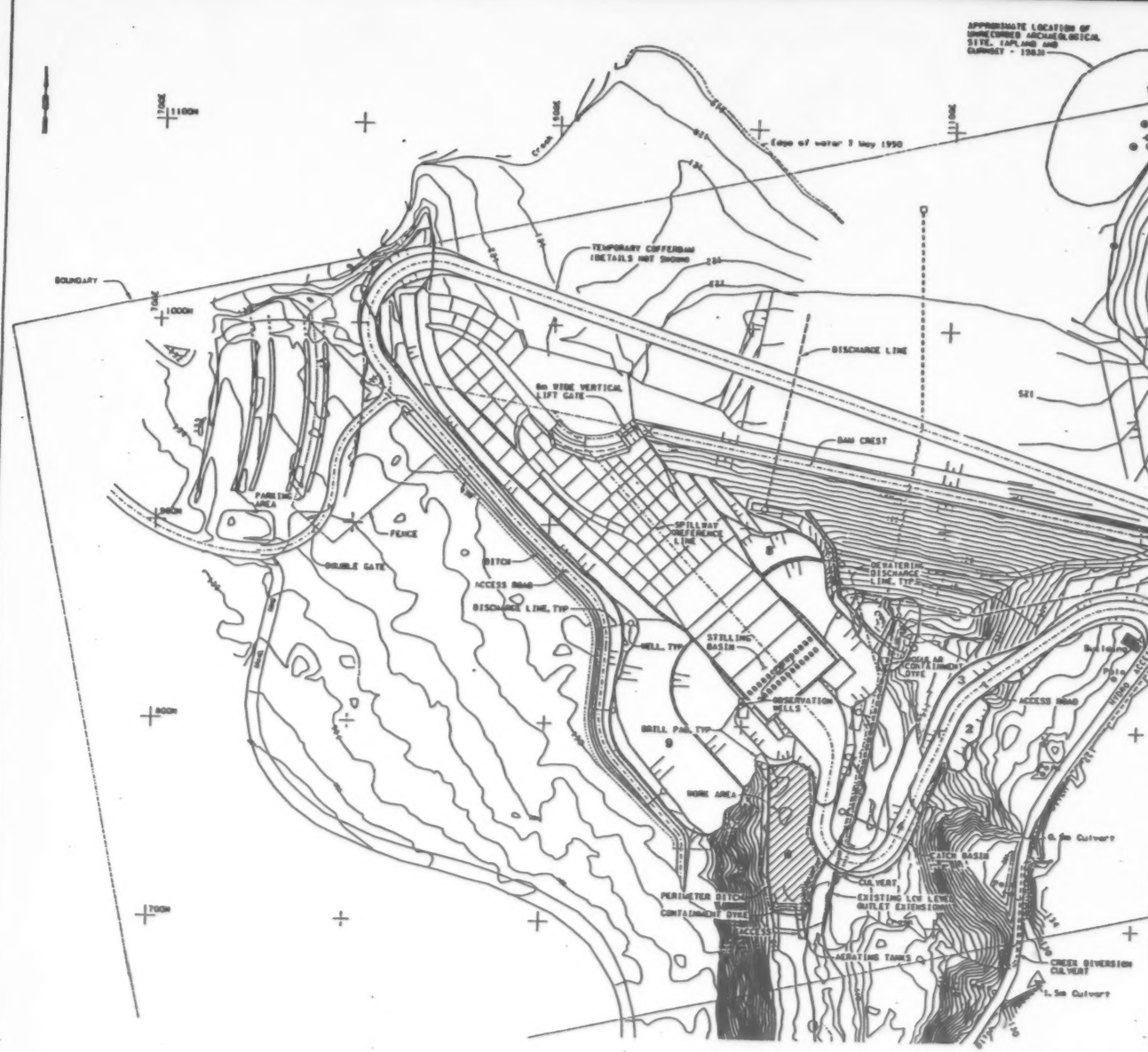
ALOUETTE SPILLWAY REHABILITATION

Access Location and Rehabilitation Plan

Fig 8-1

Appendix 9: CLEARING AND EXCAVATION REHABILITATION PLAN

The following plan specifies procedures for rehabilitating areas disturbed by clearing and excavating for the for the project, including site access roads. Procedures are based on reccommendations contained in Appendix A of the Report to British Columbia Hydro and Power Authority on Sediment Control Procedures for the Alouette Dam Spillway Rehabilitation Project (Appendix 6).



ZONE	TEMPORARY	PERMANENT
1,2	FERTILIZE AND SEED GRASS AND LEGUME INSTALL LIVE POLE STAKING AS PER SEDIMENT AND RUNOFF CONTROL PROCEDURES	SEED RED ALDER AND BIG LEAF MAPLE, PLANT SALMON BERRY (50 PLANTS)
4	—	ADD NATIVE SOIL ~20m³ FERTILIZE SEED GRASS AND LEGUME SEED RED ALDER, PLANT SALMON BERRY AND WILLOW CUTTINGS ALONG RIVER CHANNEL (200 PLANTS)
5	—	FERTILIZE AND SEED RED ALDER PLANT SALMON BERRY AND WILLOW ALONG L.L.O CHANNEL (60 PLANTS)
6	—	REMOVE WORK AREA SURFACE (TO ±150mm) ADD NATIVE SOIL 100m³ SEED RED ALDER, GRASS AND LEGUMES PLANT SALMON BERRY AND WILLOW CUTTING ALONG STREAM EDGE (400 PLANTS)
7	—	FERTILIZE, SEED GRASS AND LEGUMES
8	FERTILIZE, SEED GRASS AND LEGUMES	FERTILIZE, SEED GRASS AND LEGUMES
9	FERTILIZE, SEED GRASS AND LEGUMES INSTALL LIVE POLE STAKING AS PER SEDIMENT AND RUNOFF CONTROL PROCEDURES	SEED ALDER AND BIG LEAF MAPLE, SEED GRASS AND LEGUMES
NOTE	SEEDING TO BE COMPLETED AS SOON AS SITES ARE AVAILABLE LOOSEN TOP .15m OF SOIL PRIOR TO SEEDING IRRIGATE DURING EXTENDED DRY PERIOD (ONE WEEK WITHOUT RAIN)	

TEMPORARY COVER MIX

VARIETY SPECIES	% BY SPECIES COMPOSITION	% BY WEIGHT
ANNUAL AND PERENNIAL RYE	20	37.5%
CLIMAX TIMOTHY	15	6.08
KAY ORCHARD GRASS	10	10.52
BOREAL CREEPING RED FESCUE	15	12.72
GRENORA CANADA BLUEGRASS	10	2.82
ALSIKA ALSIKE CLOVER	15	10.41
LADINO WHITE CLOVER	5	9.04
PACIFIC DOUBLE CUT RED CLOVER	10	16.82
Apply @ 50 kg/ha		
FERTILIZER 11-48-0 @ 220 kg/ha		
WOOD FIBRE MULCH @ 200 kg/ha		

PERMANENT COVER MIX

	% BY SPECIES COMPOSITION	% BY WEIGHT
BOREAL CREEPING RED FESCUE	15	12.09
CLIMAX TIMOTHY	10	2.19
KAY ORCHARD GRASS	20	16.98
TALL WHEATGRASS	5	23.39
REVERDY CANADA BLUEGRASS	10	1.91
GRENORA KENTUCKY BLUEGRASS	5	1.12
PACIFIC DOUBLE CUT RED CLOVER	15	14.99
LADINO WHITE CLOVER	10	4.79
WL 225 ALFALFA	10	17.05
Apply @ 75 kg/ha		
FERTILIZER 13-13-13 @ 300 kg/ha		
WOOD FIBRE MULCH @ 400 kg/ha		

RED ALDER TO BE SEEDED @ 1 kg/ha
BIG LEAF MAPLE TO BE SEEDED @ 3 kg/ha

NOTE #3 ZONE 3 IS ROCKFILL. NO REHABILITATION REQUIRED

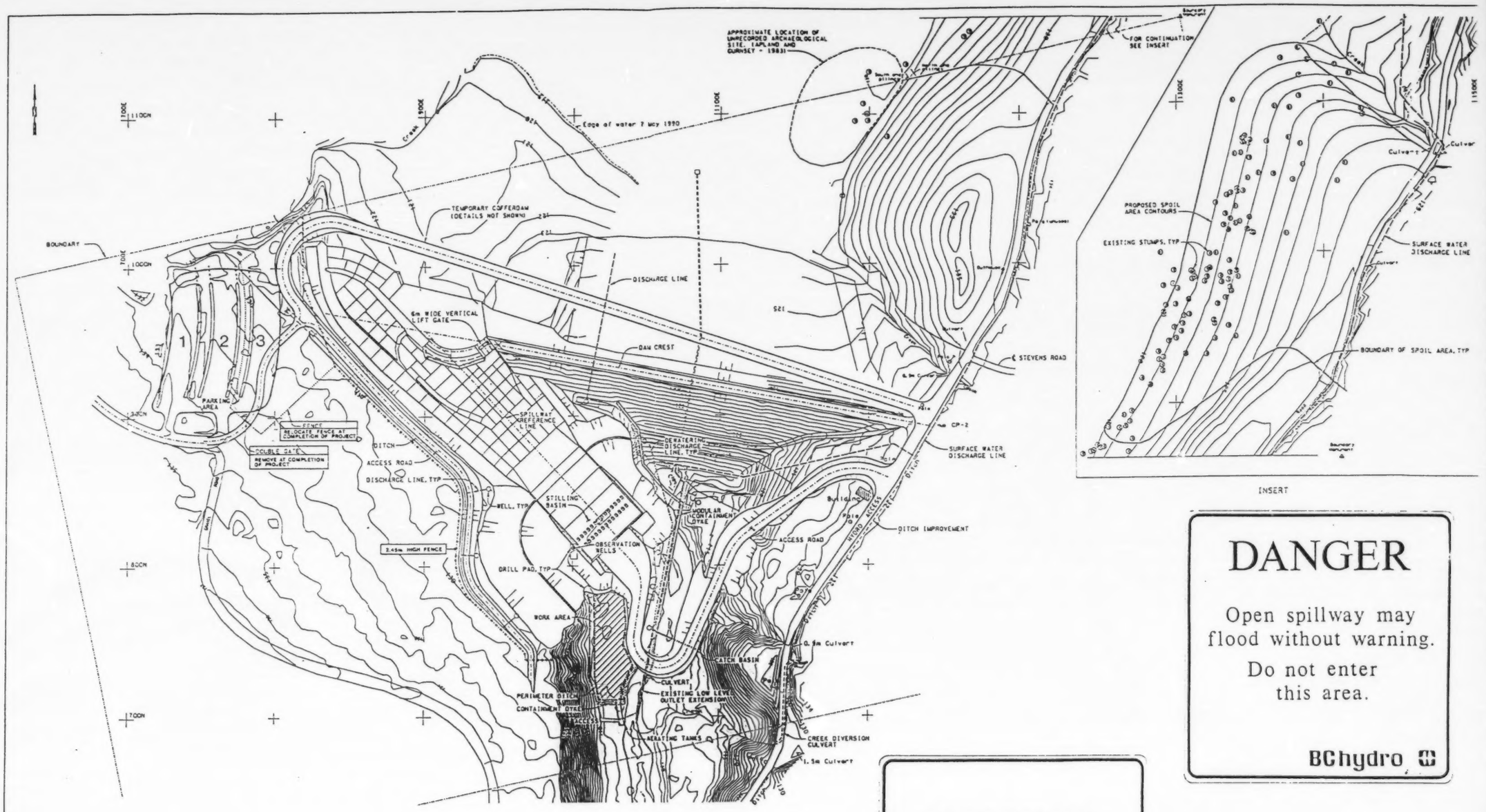
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

ALOUETTE SPILLWAY REHABILITATION

Clearing and Excavation Rehabilitation Plan

Fig. 9-1

Appendix 10: PUBLIC SAFETY, SECURITY, AND PARKING PLAN



PARKING ARRANGEMENTS	
Lots 1 and 2	Project parking Mon-Sunday Public parking Saturday and Statutory Holidays June 19 - September 19
Lot 3	Closed to public during project
Fence	permanent location —·—·—·— Temporary location — — — —

PUBLIC SAFETY
- INSTALL HAZARD WARNING SIGNS ON FENCE
- REINSTALL EXISTING DEBRIS BOOM AT COMPLETION OF PROJECT
- INSTALL PERMANENT HAZARD WARNING SIGNS AT COMPLETION OF PROJECT

DANGER

Open spillway may flood without warning.

Do not enter this area.

BC hydro

DANGER

Construction Project

Do not enter.

BC hydro

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

ALOUETTE SPILLWAY REHABILITATION

Public Safety, Security and Parking Plans

Fig. 10-1